JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE

State of Pennsylvania,

AND

AMERICAN REPERTORY.

MARCH, 1846.

CIVIL ENGINEERING.

Description of the Great Britain Iron Steam Ship, with Screw Propeller; with an Account of the Trial Voyages. By THOMAS RICHARD GUPPY, ESQ., C. E.

(From the Proceedings of the Institution of Civil Engineers.)

Concluded from page 84.

Mr. J. Field, V. P., said he had received a communication from Lady Bentham, relative to some of the improvements in naval architecture, introduced by the late Sir Samuel Bentham, which appeared to be so interesting that, with the permission of the President, he would request a portion of it might be read to the meeting.

The communication commenced by stating that, as in the paper on the construction of the *Great Britain*, particular stress was laid upon the advantage of fixed water-tight bulk-heads, dividing the hold into several compartments, the merit of the first introduction of that great improvement in naval architecture must be claimed for Sir S. Bentham: it then proceeded,—

"On reference to his Naval Papers, it appears that in the year 1795, he was entrusted by the Lords Commissioners of the Admiralty to construct six vessels of war, according to his own ideas and under his direction, at Redbridge. In the Naval Papers, No. 8, part 8, 'Improvement in vessels of War,' a short communication is given of the

several expedients he introduced into them, with a view to strength, durability, efficiency, and diminution of cost, (page 91,) it appears that he had introduced in those vessels 'fixed bulk-heads, or partitions formed in a manner calculated to contribute to strength, both in the transverse and longitudinal directions; that they comprehended in their construction diagonal braces, at the same time that they served as partitions for the convenience of habitation or for the separation of stores;' that they connected the bottom, sides, and decks together, so as to prevent their racking or working at sea; that 'a farther use of these partitions was, that having been made water-tight, as practised by the Chinese of the present day, as well as by the ancients, they tended to secure the ship against foundering, by confining the water from a leak to the space between two partitions.'

"Again, (page 99,) amongst the various expedients enumerated, as tending to diminish the danger of material injury or the loss of a ship in case of her striking the ground, it is stated, that 'the interior of the vessel having, as above-mentioned, been divided into several water-tight compartments, it is not even the flowing of water freely into one or two of these compartments that would endanger the loss of the ship.'

"So also in 'The Elements and Practice of Naval Architecture,' (page 177, third edition) in giving an account of the above-mentioned vessels of Sir Samuel Bentham's construction, the author says, 'the mode of structure of these vessels is very different from that of others;' and after mentioning various particulars, says, 'but the principal strength seems to depend on the thwartship braces and bulk-heads, which connect the sides together more conformable to the practice of civil architecture.'

"Besides these fixed bulk-heads, the metallic water-tanks (invented by Sir Samuel Bentham for the preservation of water,) were, on board these vessels, 'so contrived that their fore and aft partitions, extending in height from the bottom of the ship to the deck, operated as supports to both bottom and deck.'—Naval Papers, No. 8, page 108. So also 'the metallic canisters for keeping powder were adapted to the shape of the vessel.'

"It may be added, that other of the improvements introduced, I understand, in the *Great Britain*, had, as well as the water-tight compartments, been half a century ago exemplified in Sir S. Bentham's vessels; such as the tumbling-out of the topsides and the straight decks.

"The above-mentioned-work, 'Elements and Practice of Naval Architecture,' and Sir S. Bentham's 'Naval Papers,' Nos. 2, 7, and 8, record the extraordinary strength and efficiency of his vessels, as well as a variety of peculiarities in their construction, whereby that strength was given, with about half the quantity of timber used in the customary mode of construction, and only one-sixth part of the copper was used for fastenings.

"This statement cannot in any way detract from Mr. Guppy's merit in the construction of the *Great Britain*. Real genius disdains to appropriate, without acknowledgment, the improvements of others;

thus Sir S. Bentham, referred, as above, to the Chinese and to the ancients. Whether Mr. Guppy may have re-invented the expedients in question, or have perceived the advantage of them, as proved by the actual service of the vessels in which they were exemplified, and have adopted them, to him must be ascribed the benefit which ship-building cannot fail to derive from his introduction to general use, of Sir S. Bentham's improvements in naval architecture."

Sir. J. Rennie, President, after expressing to Mr. Guppy, the thanks of the meeting for the communication which had given rise to so interesting a discussion, said the construction of iron sea-going vessels was a subject of peculiar interest to the institution, as to one of its early members must be ascribed the merit of their first introduction.

The first iron steam vessel that ever went to sea was built in 1820-1, at the Horsely iron-work, near Birmingham. It was named the *Aaron Manby*, after the constructor; and being put together in the Surrey Canal Dock, took in a cargo of rape-seed and iron castings, in the Thames, and landed it at the Pont Royal, at Paris, without transhipment. This unique voyage was performed under the command of Captain Sir Charles Napier, R. N., who was largely interested in the undertaking, and devoted much time and his usual skill and energy to the enterprise. The engine was put together and was worked during the voyage by the present Secretary of the Institution. The propellers were the feathering paddles, which were invented by the late Mr. John Oldham. Both the engine and the paddles had been superseded by more perfect machinery, and the boilers had been frequently renewed; but the hull of the vessel had required but little repair, and was still at work upon the Seine, as were several other iron vessels built by Mr. Manby, about the same time, at Horseley, and at his works at Charenton, near Paris.

The introduction of iron, as a material for ship-building, was now becoming so general, that the result of the great experiment, the *Great Britain*, must necessarily be regarded with much interest, and next session the Institution would look forward to receiving from Mr. Guppy an account of the first few voyages; and if skill and experience could accomplish them, they might be considered safe in the hands of Captain Hosken, whose success in the *Great Western* had been so decided.

Since the receipt of the communication from Lady Bentham, before referred to, the Secretary has received, from the same source, the following additional paper:—

It is now half a century since Sir Samuel Bentham, in conversation with the First Lord and other Lords of the Admiralty, satisfied them, that the general principles of mechanics were as applicable to naval as to civil architecture, although they never, up to that time, had been scientifically applied to the construction of ships. The consequence was, that the Admiralty induced him to undertake the construction of six vessels of war and a water vessel, in every respect conformable to his own uncontrolled ideas, and under his sole direction. These vessels were the sloops, the *Arrow* and the *Dart*, and

the schooners, the *Netley*, *Milbrook*, *Redbridge*, and *Cling*; all vessels of war.

"These vessels differed, in exterior form, from the general build of vessels of war, having been larger and sharper; they projected or raked forward above the water-line, like a wherry; the top sides, instead of retiring inwards, were continued flaring outwards to the upper edge. By this difference in form, the vessels were better supported than the usual ones, when pitching or rolling in a sea, and it was found that they both pitched and rolled easily. In actual service they proved excellent sea boats, sometimes keeping their stations on an enemy's coast when other ships of war were forced to run for safety; sometimes making their port when all other vessels on the same station were driven down channel; sometimes out-sailing vessels in company at sea. The *Netley* was the only vessel on the station that could be sent in-shore off Havre, in the night, because she was the only one that could be depended on for working off a lee-shore in any weather, 'when they dared not trust the frigates.' To use the words of the 'Elements and Practice of Naval Architecture,' 'They have, generally speaking, been found to sail remarkably well; but in a head sea and tempestuous weather, their superiority as sea boats has been most decided.'

For giving strength to these vessels several new expedients were introduced, such as—

In the Construction of the Vessel:

1. Diagonal trusses, or braces of oak, to prevent racking.
2. Fixed bulkheads, longitudinal and transverse, for fixing the bottoms, sides, and decks together.
3. Thick, strong pieces under the ends of the beams, in lieu of knees.
4. Increased thickness of the outer planking, and of the deck.
5. Straight decks fore and aft.
6. Placing the timbers at right angles to the rising line of the dead wood, instead of being all the way perpendicular to the keel.
7. Passing the beams between the timbers, so as to afford means of connecting the beams immediately to them.
8. Choice of timbers; namely, that of small scantling but well seasoned, by having lain long in the sap.
9. Avoiding the use of grain cut timber.

In respect to Fastenings:

10. Trenails of a shape of his invention, in steps, that is, of different diameters in different parts of their length, the greatest at their head, the least at their point, with conical-heads engine-turned. These trenails held faster than the usual ones, yet the timbers in which they were inserted were less wounded than by the ordinary trenails.

11. The use of augers for making holes of corresponding exactness with the trenails, so that the holes might be perfectly filled up, to the exclusion of water and moisture. These trenails, so inserted, kept the planking of the bottom in perfect contact with the timbers, notwithstanding the most severe caulking.

12. Short metal screws, hollow in the thickest part, the heads of a shape for holding firmly, and more particularly for fastening the butt-ends of the plank.

13. Bolt nails of a mixed metal, of a shape and of a hardness that admitted of their being driven into oak or fir, without splitting the wood.

14. Instead of bolts, only clenched on rings. A new description of bolt, with screws on the ends; nuts to screw upon them, and plates, both for screwing the nuts against, and for receiving the heads of the bolts. Thus the bolts were not only drawn more firmly at first, but they admitted of being screwed up more tightly, in case of shrinkage of the wood.

15. Nails of a new form for sheathing, having flat and smooth heads, and tapered only in one direction; of pure copper, instead of mixed metal; thereby not liable to contaminate the sheathing on re-melting.

Expedients against Loss by Injury to the Bottom, and against Foundering.

16. Extra thickness of plank for the lower part of the vessel, as above-mentioned; it having been 6 inches instead of only 3 inches, as usually employed.

17. Terminating the plank against the dead-wood, so that the dead-wood, the lower part of the stern-post, or even the keel itself, might have been beaten off, without letting water into the vessel.

18. Giving such a form to the rudder, that although the bottom part might have been beaten off, still enough would have remained to steer the ship by.

19. In the *Arrow* and the *Dart*, hawse-holes in the stern, the same as in the bows, to enable them to be brought to anchor in a narrow channel, riding stern-foremost.

20. A pre-eminent improvement against foundering, was the water-tight compartments, first introduced in these vessels. That is, the longitudinal and transverse bulk-heads, so efficient, as above-mentioned, in point of strength, by being made water-tight, divided the vessel into several water-tight compartments, so that, although water should have entered into two or three of these compartments, the vessel would not sink.

Against Accidents from Explosion.

21. Instead of casks, metallic canisters for keeping powder. These canisters were air and water tight, and were so arranged, as that in case of alarm of fire, water might easily have been let in over and around them, without injury to the powder, and so that after the danger were over, they could speedily be laid dry again.

22. Safety-lamps in lieu of a magazine light-room. These lamps were encompassed by a double casing of glass, filled in between with water; the whole so contrived, that in case of the breakage of the glass, the water would extinguish the light.

Expedients with a view to Efficiency in point of Stowage-room, and to the Health and Comfort of the Crew.

23. Instead of store-rooms, against the sides of the ship, fixed bins, not higher than tables were introduced, leaving a clear space around them, as well as above them, so that besides easier access to the stores, the sides of the vessel were left clear to get at them, to stop shot holes.

24. The powder canisters were adapted to the shape of the vessel; consequently a much greater quantity of powder would be stowed in a given space, than where the powder was in casks.

25. The invention of metallic tanks for holding water, instead of casks; with a view to the preservation of water sweet at sea.

26. The adapting those tanks to the stowage of a much larger store of water than usual. This was effected by forming them to the shape of the vessel, so that no space was lost between them and the sides, nor between one and the other of them, as necessarily must be in the case of casks. The framing of these tanks also contributed to the general strength of the vessel, by its extending from the bottom to the deck, and so connected to them, as to form a part of the general fabric.

27. Thick pieces of glass as illuminators, either flat or convex, were introduced in various parts of the vessel, usually dark, but where light was very desirable.

28. Greater distance than customary between deck and deck, so as to give height for the men to stand upright.

The expedients introduced in these vessels with a view to economy in their structure, were—

In regard to Timber:

29. The use of small timber, of which there was abundance in that market, instead of large timber, of which there was an increasing scarcity, the smaller timber being from 25 to 50 per cent. cheaper than the large.

30. The use of timber of kinds less costly than oak, but using those cheaper kinds only in parts for which they were appropriate, as elm and beech, for parts always under water, fir for parts where strength was required, in resistance to tension, in the direction of the fibre.

31. No knees.

32. No crutches nor breasthooks.

33. No carlings nor ledges.

34. Little or no footwalings, circles, or inside planking.

In regard to Metal :

35. Short metal screws.

36. Screw-pointed bolts, whereby half the usual number of bolts was saved.

37. Sheathing nails of pure copper.

38. Bolt nails of mixed metal, instead of copper.

The efficiency of these expedients for their intended purposes was proved in the long and active service of these several vessels.

In point of strength, they were exposed to a variety of severe trials without injury. Amongst others, the *Milbrook*, after launching, was left dry at low water near Southampton by some accident, across and hanging on a log of wood; her sheer was not broken, nor did she sustain any other injury. The *Dart*, in the year 1799, with her guns and stores on board, ready for action, on going up the Texel, with much smaller vessels, and where no other of her force and size dared venture, frequently got aground, and dragged and beat against the shoal, without being in the least injured. The *Redbridge*, of no more than 160 tons, yet carrying fourteen carronades, sixteen pounders, had one of them, by accident, loaded with three shot, together with the full charge of powder, and which was fired off without the least injury to the vessel. On board the *Dart*, one of her thirty-two pounder carronades was fired no less than eighty rounds successively, and with an expedition far exceeding what is possible with ordnance mounted in the usual manner, yet the vessel was not in the least affected by it. On the same occasion, the *Cling* fired four hundred round shot from her aftermost carronade, without doing the slightest injury on board. In many letters it was stated that, after storms and the roughest weather, not so much as the paint or whitewash on the seams of the six several vessels had been disturbed. On an official survey of the *Dart*, and this after she had been in service seven years, it is stated in the official reports of that survey, and amongst many other proofs of strength, 'I do not find one decayed timber in her; a circumstance extremely uncommon in ships of such an age. I do not perceive an evidence of even the pitch of the butts on the gangway having cracked. On the most minute survey, more than once or twice, I discovered not the least sign of working. The calking at the wooden ends was perfectly sound and good. The oakum in the seams was perfectly dry and solid; even the indents remain in it, caused by the sawn edges of the plank, &c.'

It seems proper to add, that the *Dart* had been in many actions previous to that survey.

In respect to the expedients against foundering, besides the examples these vessels afforded, of their security after beating on the ground, it must be noticed that, since of late water-tight compartments have been adopted, striking instances have occurred of the preservation of life by this expedient.

As to Stowage-room, and Health and Comfort of the Crew.

The space gained by the above-mentioned and other minor arrangements may best be judged of by a comparison of that between decks in an eight-and-twenty gun frigate and the *Dart*. In a frigate of 28 guns taken for comparison, there were but 10,278 cubic feet between decks; whilst between decks of the *Dart* there were 19,306 feet; or in the frigate, 52 feet to a man; in the *Dart* sloop, 137 feet to a man.

The *Dart* and *Arrow* were of about 500 tons; but though carrying the number of guns of a 28-gun frigate, they had a sloop's complement of men.

A much greater quantity of powder and of various other stores

were stowed in a given space. The quantity of water was nearly double; and, what is of great importance in regard to this necessary store, by the invention of metallic tanks water can be preserved sweet at sea. A quantity of water, that had been no less than three years in one of the tanks on board the *Dart*, having been sent, in the year 1800, duly verified in every respect, to the Society of Arts, their honorary gold medal was awarded to Sir Samuel Bentham for this invention.—(*Vide* Trans. Soc. Arts, vol. xix, 1801, pp. 191 and 374.)

Metallic tanks have since been very generally adopted, with the difference in favor of those now used, that they are of the cheapest metal—iron; but, on the contrary, they have usually the disadvantage of not being shaped to the form of the vessel, and of not contributing in any way to the strength of its structure.

Saving of First Cost.

It appeared from the report of the master shipwright of Deptford Dockyard, on comparing the quantity of timber employed for the *Dart* with that consumed for a frigate of the same size, the *Maidstone*, and taking into account, in both cases, the loss on conversion, that not a seventh part of that used for the *Maidstone* had been necessary for the construction of the *Dart*.

The absolute saving in copper, together with that of the timber, was so great, that a contractor dealing with the Navy Board, and conversant with the structure of these vessels, made a direct offer to that Board, to build a frigate, according to this new mode of structure, for little more than half the price paid for vessels of the same magnitude, according to the usual mode.

In addition to the improvements exemplified in the above-mentioned vessels, may be specified, Sir Samuel Bentham's invention of "Coqueing."

This mode of connexion, he described, as applicable to framed work in general, in all cases where the force to be resisted tends principally to make the pieces slide one over the other. It was particularly noticed and approved of by the Lords of the Admiralty, on their visitation of the Dock Yards, in the year 1802.

The most important advantage of this invention, is the very great additional strength given to vessels of which the parts are so combined. Besides this, savings are effected by it in various ways; by the saving of timber, for instance, where coqueing is employed, instead of tabling, as in making masts, in which case the saving of workmen's wages alone, amounted to 25 per cent.; that having been the reduction made, on the price paid them for putting masts together, when this mode was introduced.

This invention was soon very generally adopted by private ship builders, and has been used in some cases of civil architecture and engineering, to which arts it is equally applicable. The Ordnance Department also very soon adopted it.

Lond. Mech. Mag.

On the Construction of Fire-proof Buildings.

The introduction of fire-proof buildings in the manufacturing districts has undoubtedly been attended with the happiest results in the preservation of life and property. Their adoption for ware-housing goods is of more recent date, but as far as we can yet judge by experience, they have proved equally beneficial for this purpose. The merchants of Liverpool, especially, have been burned into the conviction, that fire-proof warehouses must be an improvement, and in that city their employment for new warehouses is becoming universal. The general principles on which those buildings should be constructed have been clearly enumerated by Mr. Fairbairn, in his able Report on the fire-proof warehouses of Liverpool, and already published in the preceding volume of this Magazine. It is the object of the present paper to enter more minutely into the details of their construction, taking as our guide the practice of Mr. Fairbairn and other trustworthy engineers. But before doing so, we would quote from the Report above cited, the following observations upon the peculiar kind of stability possessed by these structures, as this is a point which must never once be lost sight of in proportioning and fixing the various parts. The Report proceeds—

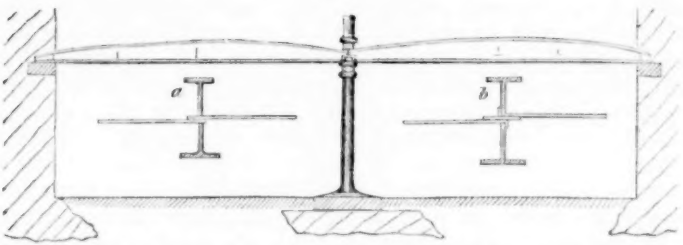
"There can be no doubt that if a fire-proof building is constructed as it ought to be, it is the most secure in every respect; but on the other hand, if unskilfully or dishonestly constructed, it is of all others the most dangerous. This is owing to the manner in which the lateral pressure of the arched flooring is distributed, so that should a single beam or column be broken, or the tyre-rods be displaced, the destruction of the whole building is almost inevitable. It does not admit of partial excellencies or defects—it must be either secure or insecure, either skilfully designed and positively right, or unskilfully designed and positively wrong."

1. Pillars.—It has been known for some time that the strongest form in which cast-iron pillars can be made is a hollow cylinder, and accordingly this form is now universally adopted. For pillars of 5 to 6 inches diameter, the thickness of metal should be from $\frac{1}{2}$ to $\frac{5}{8}$ in., and from 8 to 10 in. diameter, 1 in. to $1\frac{1}{8}$ thick. From Mr. Hodgkinson's recent experiments on the strength of cast-iron pillars, published in the Philosophical Transactions of Manchester for 1840, (and elsewhere,) we have the data for calculating their strength with great precision: for example, we find by his tables that a hollow pillar 8 in. diameter, 1 in. thick, and 20 feet long, will support, without flexure, 637 cwt.; the same pillar 16 feet long will support 673 cwt.; and if 12 feet long, 699 cwt., and so on for pillars varying in diameter, thickness, and length. It is a point of the utmost importance in fixing the pillars that they shall have a solid bearing at top and bottom, their strength being influenced in an extraordinary degree, according as their ends are shaped.

Thus it was found by experiment that a pillar with both ends terminating in flat disks broke with 9007 lbs.; a pillar of the same dimensions in every respect, but with one end flat and the other turned hemispherically, broke with 6278 lbs.; whilst a third pillar of the same

dimensions, but with both ends turned hemispherically, broke with 3017 lbs.—these numbers being nearly in the ratio of 1: 2: 3. The ends of the columns are usually shaped as shown in fig. 1, which represents a side-elevation of the beams, showing the position of the tye-rods, &c. The different methods of keying the beams are shown at *a* and *b* of the same figure.

FIG. 1.



2. Beams or Girders.—According to Mr. Hodgkinson's valuable experiments on cast-iron beams, the strongest form in which a given weight of metal can be cast, is that represented in fig. 2, which is a plan of the beam, the flanches of which taper to each extremity in a parabolic curve. At *d* the ends are made circular, to embrace the head of the column, and at *e* joggles are cast on the end of each beam, and bound with a wrought-iron strap to keep the ends together.

FIG. 2.

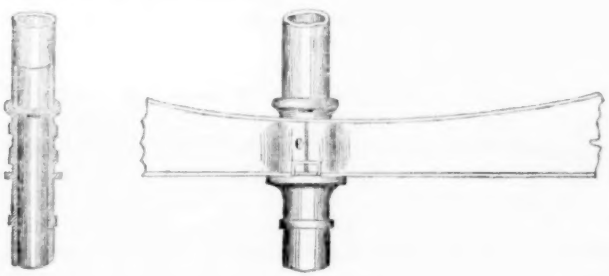
For proportioning these beams, the following may be relied on as a sound practical rule, viz:—Take the "breaking weight" at from two to three times the weight estimated to be carried by the beam, then assume the depth of the beam at about $\frac{1}{10}$th part of the distance between the supports (for ordinary cases,) and the sectional area of the bottom flanch may then be found by the following proportion, viz. as the depth in feet of the beam in the middle is to the distance between the supports in feet, so is one twenty-sixth part of the breaking weight in tons to the sectional area of the bottom flanch in square inches. Make the thickness of the bottom flanch one-twelfth part of the depth of the beam, and find the breadth by dividing the area by the thickness. Make the area of the top flanch, one-fifth part of the area of the bottom flanch, and half its breadth. Make the thickness of the web of the beam rather more than half the thickness of the bottom flanch, for the beam when cast, but the pattern may be made somewhat thinner. It is usual to make the web of all beams under 16 inches in depth about $\frac{9}{16}$ths in. thick in the pattern, as the metal will not run well if thinner. In general, it is recommended to reduce the depth of the beam at the ends to $\frac{2}{3}$ds of the depth in the middle,

and this reduction must be made on the upper side of the beam. But in many cases the beam is preferred to be parallel in depth throughout. In all cases it is advisable to reduce the breadth of the flanches at the ends to one-half their breadth in the middle, and this should be done by a parabolic curve, as by that means the strength of the flanch at each point will be exactly proportioned to the amount of the strain thrown upon it in a uniformly loaded beam. From the nature of the parabolic curve the lengths of the ordinates vary as the rectangles contained by the segments of the chord cut by the ordinates; but it has been ascertained by experiment that those rectangles are also proportional (in an inverse ratio) to the strength of the beam at those points, hence the breadth of the bottom flanch will be a direct proportional to the strength of the beam, at each point. By the adoption of these improved forms of beams a saving of about $\frac{1}{3}$d in the weight of the material is effected, when compared with the older forms of cast-iron beams which were in use only a few years back. As a general rule for beams of this class, their strength is nearly a proportional of the sectional area of the bottom flanch. It was found by experiment that a T beam broken with the flanch downwards, bore a weight represented by 1000, but when reversed, it only bore 323.

In proportioning the strength of beams, it must be borne in mind, that a load of 10 tons on the centre is equivalent to 20 tons distributed equally over the beam, or to 15 tons placed upon two points, each a third of the length of the beam from the end.

The pattern for such beams should be made $\frac{1}{16}$ inch to the foot, round on the under side, to allow for the drawing of the metal in cooling. The usual manner of fixing and keying the beams is explained in fig. 3, which is an enlarged view of a column and beams. The upper column fits into a bored socket on the head of the under one, which is also prepared by chipping and filing to receive the ends of the beams, these being fastened together by the straps, already mentioned, round the projections at *e*.

FIG. 3.



3. Tye-rods.—These act a most important part in a fire-proof building by tying together the walls and the beams in a species of net-work, and by assisting them to resist the lateral strain, caused by the flat brick arches of the flooring. With this view their obvious position should be near the bottom of the beam where they form the chord of the

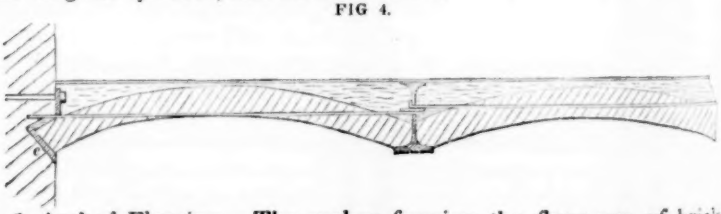
arc; but as this would be inconvenient, especially in low-floored buildings, from the loss of head-room, it is usual to bury them in the brickwork, keeping them, however, as low as possible, or just at the soffit of the arch. In this position they will generally perforate the neutral axis of the beam, and without injuring its strength, afford sufficient security to the arch. The usual practice in the manufacturing districts is to have 5 lines of ¾-inch square rods in a width of 30 feet, two lines being imbedded in the side-walls, and the remainder built into the arches. This is considered perfectly secure for a cotton-mill, but in a warehouse, where the floors are much more heavily laden, there should be in the same width seven lines of rods, each 1¼ inch square. This will give a sectional area of about 11 square inches in 30 feet, which, taken at 25 tons to the square inch, will give a tensile strength equal to 275 tons. In factories, the tensile strength of the tye-rods need not exceed 100 to 110 tons for this width, or nearly 4 tons to the foot, but for warehouses, this should not be less than from 9 to 10 tons. Two of the modes in most general use for keying the tye-rods are shown here; it will be remarked, that a line of rods tye the heads of the columns together.

4. Skewbacks.—Into the end walls are built arch-plates of cast-iron, technically called "skewbacks," to resist the thrust of the last arch, and they are keyed to the beams in the usual manner. By this means all lateral strain is taken off the end walls, provided the tye-rods have the requisite tensile strength for retaining the beams in their proper positions.

The skewback, as well as the ends of the beams, should be fixed a little higher than their proper level, to allow for the settling of the walls, which invariably takes place as their weight increases by their ascent.

The ends of the beams must be bedded either upon hard stone built into the wall, or on a cast-iron wall-plate, and the ends resting on the columns chipped and filed, to ensure a perfect bearing; likewise the ends of the columns where they fit to each other. Fig. 4 is a cross-sectional view of the beams and arched flooring on a larger scale, showing the tye-rods, and the skewback *e*.

FIG 4.



5. Arched Flooring.—The arches forming the floor are of brickwork, and stretch between the beams, being supported by, and springing from the bottom flanch of each. The versed sine, or rise, of the arch, should be 1½ inches to the foot of span, to ensure perfect safety, and in no case should be less than 1¼ inches, below which they become positively dangerous. They are generally filled up at the haunches and leveled with a concrete of sand, lime, and ashes, and the floor laid with flags, slates, or tiles, bedded in mortar. The weight of such a

floor, irrespective of the weight of the beams, may be estimated at from 14 to 16 square feet of horizontal surface to the ton, supposing the arches to be about 10 or 12 feet span.

Glasgow Prac. Mec. & Eng. Mag.

Report of the President and Managers of the Schuylkill Navigation Company, to the Stockholders. January 5th, 1846.

The President and Managers respectfully present the following annual Report.

The navigation was opened for the season, on the 10th of March, 1845, and continued open until closed by ice in the beginning of December.

The tonnage transported upon the line, as per the returns of the Collectors, has been 467,742 tons; of which 263,587 tons were coal, and 204,155 tons miscellaneous freight. A large amount of materials for the new work, not included in the foregoing, should be added, estimated at 75,000 tons, and making the total more than 540,000 tons.

This trade was very unequally distributed through the season. In the early part of it, the re-construction of two of the principal branch railroads in the coal region cut off from the navigation two of its main sources of supply; and after those roads were completed, it was sometime before individuals had the necessary new landings ready for use. As the season advanced the shipments increased, and during the latter part of it all the boats were actively employed; the demand for them became so great, that coal freights, which had been at 70 cents per ton from Pottsville to Philadelphia, and $1·80 from Pottsville to New York, rose fifty per cent. upon those prices, and enabled the boatmen to make large profits.

The direct coal trade to New York amounted to 116,610 tons, being 5,089 tons more than in 1844.

If the boats upon the line had been more numerous, the coal shipments would have been larger.

Few boats adapted to the old locks have been built for several years past; * * * * * * * the scarcity of boats limited the trade—the small size of the locks excluding the boats of other canals.

The universal voice of those concerned in the Schuylkill coal business, and of the great body of the residents and proprietors of manufactories along the line, having for some time past called for the further improvement of the navigation, the building of new boats was in a great degree suspended, as individuals were awaiting the decision of the Company on this all-important point.

The Stockholders having resolved, at their last annual meeting, to enlarge the works and improve the line, so as to pass boats of three times the present tonnage, individuals have begun to build boats adapted to the size of the new locks; and the Board of Managers having negotiated a special loan for the purpose, have already con-

tracted for about one hundred, to be under the control of the Company.*

With the present boats of 60 tons, the cost of carrying coal, including freight and toll, has been brought down to one cent per ton per mile; at which rate large quantities have been transported. Several cargoes of 73 tons each have been shipped this season.

In pursuance of the policy of stimulating the trade of the Schuylkill region, and granting every inducement in their power to those concerned in mining, to extend their operations, the Board again fixed the toll on coal at one-third of a cent per ton per mile, and adopted a rate of four mills per 1000 lbs. per mile on miscellaneous freight. Having obtained authority from the legislature to own boats and cars, and to effect such financial operations as might be necessary to accomplish the completion of the Company's improvements, the Board provided 150 cars for the use of some of the operators, whose mines were not far distant from the river, and made allowances for the use of the cars and landings of individuals. An arrangement was also made with the proprietor of a steam tow-boat, to afford facilities for towing Schuylkill and Union canal boats between the two fronts of the city of Philadelphia.

The rapid progress of the trade of the valley of the Schuylkill is shown by the following summary:

	Tons of coal by Canal and Railroad.	Miscellaneous tonnage by Canal.	Total.
1842,	541,000	152,096	693,096
1843,	676,073	146,348	822,421
1844,	840,617	174,584	1,015,201
1845,	1,083,795	204,155	1,287,950

To which should be added the amount of miscellaneous freight transported on the railroad, which, in 1844, was 20,472 tons. It will be seen by the foregoing summary, that the Schuylkill coal trade of 1845, has been double that of 1842, and that the miscellaneous tonnage by the canal has increased more than 50,000 tons. The opinion expressed to the stockholders at the last annual meeting, that more than a million of tons of coal per annum would soon be mined in the Schuylkill region, has already been surpassed by the fact; and, as the preparations making for next year's business far exceed in extent and completeness those of the past season, the best informed operators estimate the quantity to be mined in 1846, at 1,400,000 tons.

Looking at the immense magnitude that the trade has attained, at

* The Board of Trade of Pottsville, in their last annual Report to the Coal Mining Association of Schuylkill County, express their approval of the plans of the Company in the following terms:

"We are fully satisfied that the enlargement of the canal, and the application of steam, is the true and undoubted plan for cheapening the transportation on this line of improvement; and in perusing the report of the President of the Company, we have been much gratified with the clear business style of the document, and the ability with which these advantages are set forth." "When such a navigation is completed, that boats or vessels carrying from 150 to 200 tons can load at our wharves and proceed directly to New York, and other distant ports without transhipment of the coal, and be propelled by steam, we think the cost of transporting must be reduced to one-half, or perhaps one-third, of the cost in the present boats drawn by horses."

its rapid ratio of increase, at the extension of its tributaries now going on in all directions, and at the numerous anthracite iron works going into operation along the line, in connexion with the fact of the inexhaustible character of the coal mines which find their cheapest outlet by the valley of the Schuylkill, what a vast amount of transportation of coal, and ore, and limestone, and other heavy commodities, may we look forward to in five years from the present time!

It is in truth a trade only to be adequately estimated by millions of tons, and for the cheapest transportation of which your Board is satisfied that the improved Schuylkill Navigation need fear no competition. It is a trade, but a small part of which can be done in the winter, of which the great bulk must, for most of its course, be carried afloat, and which there are great advantages in shipping direct from the coal region. * * * * *

* * * * *

The opinion was expressed a year ago, that the expenditure of but little more than one-fourth of the cost of the navigation for boats of sixty tons would fit it for boats of three times the tonnage, and reduce very greatly the cost of transportation. A thorough investigation of the line, made during the year by competent engineers, has verified that opinion. The basis of the argument which induced the Stockholders to undertake the enterprize has been proved to be sound, and the reasons in its favor which were then brought forward, have been greatly strengthened by subsequent developments.

The work may be fully completed at a cost of less than one dollar per ton on the whole Schuylkill trade of this single season; and the money authorized to be raised by the Stockholders at their last annual meeting, it is found will be ample for the purpose, as appears by the report of the chief engineer, herewith submitted.

In January last, Mr. Edward Miller, a civil engineer of much experience, and of high standing and character, was appointed by the Board to take charge of the work, as the duties of the President, who had prepared the general plan of the improvement, at the request of the Board, from the preliminary surveys, confined him almost constantly at the Company's office.

Mr. Miller immediately proceeded to make a careful examination of the line, and on the 11th of March submitted a report approving of the plan adopted, and showing very forcibly the great advantages of carrying it out, which report was printed for distribution.*

*A short extract from that report [page 27.] shows the amount of tonnage which the new tier of locks will be capable of passing.

"The New York Canal Commissioners state, that in the month of June, 1836, 246 boats were passed at Alexander's lock, three miles west of Schenectady, in twenty-four hours, being one in every six minutes; they add, however, a doubt, whether at some of the locks where the point of supply is remote, more than 200 boats can be passed in 24 hours, or one in seven minutes; and this they deem the practical maximum for the Erie Canal, on account of its imperfect character.

"If we assume this for the enlarged Schuylkill Navigation, we shall have (omitting Sundays) 1200 per week, of which one-half would be loaded boats carrying 180 tons. This would give 108,000 tons per week, or 3,780,000 tons for the season of 35 weeks.

"But as there will be nine places on the Canal where it is deemed necessary to construct combined locks, though in no instance more than two together, a greater

On the 1st of March, Mr. Ellwood Morris, was appointed agent of the Company to reside at Pottsville, in which capacity he has given general satisfaction.

As soon as the amount subscribed to the loan for enlarging and improving the works was thought by the Board to authorize the measure, proposals were invited from contractors, for building the new locks, and they were allotted in the month of May, and the contracts generally signed, and the work begun in June.

For the purpose of superintendence, the line was divided into three parts, and each placed under the care of an experienced canal engineer; the three resident engineers, Messrs. Ellwood Morris, Antes Snyder, and James F. Smith, being under the control of Mr. Miller, as chief engineer.

The careful and thorough surveys made by these gentlemen during the season, have resulted in showing that the number of locks may be reduced from 109 to 70, being 12 less than was proposed last year, thereby effecting a further important saving of time and expense in transportation; that the prism of the canal portions of the line may be generally widened to 40 feet on the bottom, with proper slopes, being the width of the new channels which have been made in the river within a few years past; that the whole line may be fitted for the convenient use of boats 100 feet long by 17½ feet wide and capable of carrying from 150 to 200 tons of coal, and of being advantageously propelled by steam, by the expenditure of a sum varying but little from the original estimate, as by the report of the chief engineer, will more fully appear.

The operations of widening and deepening can be most advantageously carried on at the same time, the earth being taken from the berm side to raise the towing path bank of the canals. Arrangements have been generally made to pay by the acre for the narrow strips of ground needed for the purpose. All the engineers concur in recommending that this part of the work should be proceeded with at once, during the present period of suspended navigation, so that the line may be ready for the advantageous use of the large boats, as soon as the new locks are done. The Board concur in this opinion, and desire to impress upon the stockholders, in the strongest manner, the importance of urging on the whole work as rapidly as may be practicable, so that as large a portion as possible of the trade of next season may reap the advantages of its accomplishment.*

delay will occur at these places; and accordingly, when the trade approaches 1,890,000 tons, it will be advisable to double these locks, in order to put them on a footing with the rest."

*In the district of Mons, in Belgium, in 1844, 2,014,138 tons of coal were mined, which is now carried by means of a circuitous water conveyance, and a company having been formed to improve the means of communication, that distinguished engineer Mr. George Rennie, of London, has recommended to them to construct both a canal and a railway, the one for the coal and the other for the travel, which has been determined upon. The canal is to be 45 miles long, 33 feet wide on the bottom, and between six and seven feet deep, and the boats 111 feet long and 15 feet wide, to carry 220 tons. Mr. Rennie's report, dated 16th October, 1845, is to be found in a supplement to Herapath's Railway Journal, of November 1st. There has been much experience in both canal and railway transportation in Belgium, and the result has shown the superior cheapness of water carriage for heavy commodities.

The commencement of the enlargement and improvement of the Schuylkill Navigation has been hailed with great satisfaction by the colliers of Schuylkill county, by the boatmen, and by the residents and manufacturers along the line. They anticipate great advantages from its completion, and are making preparations for its extensive use.

And in concluding this report the Board repeat the expression of their conviction, that the true interests of all concerned in the Company require that no effort should be spared to accomplish the completion of the enterprise, at the earliest practicable day.

The financial statements of the company marked A. and B., and the tables of tonnage descending and ascending the river in 1845, marked C. and D., are herewith submitted. The miscellaneous tonnage other than coal, exceeds that of last year 29,571 tons.

All which is respectfully submitted.

By order of the Board of Managers,

SOLOMON W. ROBERTS.
President.

Office of the Schuylkill Nav. Co., January 5th, 1846.

A.

Statement of the Schuylkill Navigation Company, January 1, 1846, *excluding the enlargement and improvement of the works now in progress.*

Dr.

General charges, cost of works	$3,550,259·07
Amount paid for damages	151,011·48
Amount paid for real estate including $16,601·08 sold, not paid for	193,196·88
	3,894,467·43

Cr.

Capital Stock	$1,665 600·00
Permanent Loans (old acct.)	1,782,622·37
Bonds payable	10,327·50
Profits disbursed in payment of loans, damages, and new work	435,917·56
	3,894,467·43

B.—Statement of the Accounts of the Schuylkill Navigation Company for 1845.

Balance of Income and expense account, January 1, 1845		64,136 30	Current expenses for repairs		$36,374 82
Tolls received, 1845		135,147 19	ditto ditto salaries and wages		29,863 57
* Rents		17,336 98	Interest account		96,261 77
Unclaimed dividends		786 60	State tax		2,598 34
do. interest		4,598 74	Premiums to boatmen		600 00
Individual accounts unsettled		348 54	Towing between Fairmount and Del. front		3,865 39
Bills payable		2,000 00	Allowance for landings and cars in the Coal Region		17,887 45
Convertible Loan of 1845, settled for by subscribers		547,150 00	Old claims settled by compromise		2,260 61
Received from subscribers to Boat Loan		1,800 00	Individual accounts unsettled		2,240 81
			Schuylkill Navigation Company Stock,		500 00
			Loans of the Schuylkill Nav. Co. held by the President in trust. Loan of 1837	$78,701 32	
			Convertible " 1844	47,519 74	
					126,221 06
			Bills receivable		31,346 64
			Cash		53,977 29
			Improving and enlarging the works		213,470 13
			Discount on Convertible Loan of 1845, negotiated at 80 per cent.		109,430 00
			On account of contracts for boats and cars		40,585 91
			Disbursed in payment of loans	$7,897 82	
			ditto " of damages	3,257 72	
			ditto " of new work	1,218 48	
				$12,374 02	
			Less am't rec'd for damages & real estate	6,553 46	
					5,820 56
		$773,304 35			$773,304 35

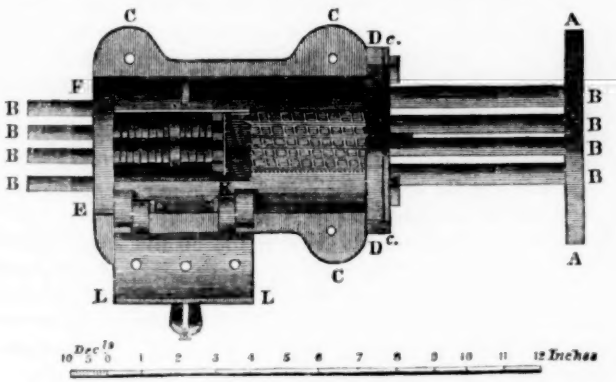
* Amount of outstanding rents $2838 50

To be Continued.

Account of Experiments upon the Force of Waves. By Thomas Stevenson, C. E., Edinburg.

In forming designs of marine works, the engineer has always a difficulty in estimating the force of the waves with which he has to contend. The information on such a matter, which is derived from local informants, who, although intelligent in the departments of trade which they follow, are, nevertheless, more or less prejudiced from being constantly on the spot, is not satisfactory; and it has, therefore, often occurred to me, that it would be most desirable if the engineer could be enabled, to some extent at least, to disregard the prejudiced statements of others, and the vague impressions left by them on his own mind, and really to ascertain by direct experiment, what force, expressed in pounds per square foot, the sea actually exerts upon the shores where his buildings are proposed to be erected.

Before considering the results obtained, however, I shall explain the construction of this simple self-registering instrument. The letters



D E F D represent a cast-iron cylinder, which is firmly bolted at the projecting flanches G to the rock where the experiments are wanted. This cylinder has a flanch at D D. L L is a door, which is opened when the observation is to be read off. A A is of iron, and forms a circular plate or disk, on which the sea impinges. Fastened to the disk are four guide rods B B B B. These rods pass through a circular plate C C (which is screwed down to the flanch D D), and also through holes in the bottom E F. Within the cylinder there is attached to the plate C C a powerful steel spring, to the other, or free, end of which is fastened the small circular plate K K, which again is secured to the guide rods B B B B. There are also rings of leather T T, that slide on the guide-rods, and serve as indices for registering how far the rods are pushed through the holes in the bottom; or, in other words, how much the spring has been drawn out or lengthened by the force of the sea acting upon the plate or disk A A. The object of having four leathern rings, where one might have answered

the purpose, was merely that they might serve as a check upon each other; and so perfectly did they answer the purpose intended, that in every instance they were found equidistant from the bottom of the cylinder; proving thereby, that, after the recoil of the spring, they had all kept their places. The guide-rods are graduated, so as to enable the observer to note exactly the quantity that the spring has yielded.*

This instrument, which may, perhaps, be not improperly termed a *Marine Dynamometer*, is, therefore, a self-registering apparatus which indicates the maximum force of the waves. In the graduation of the instrument, the power of the spring is ascertained by carefully loading the disk with weights so that when the quantity that the spring has yielded by the action of the sea is known, the pressure due to the area of the disk exposed is known also. The disks employed were from 3 to 9 inches diameter, but generally 6 inches, and the powers of the springs varied from about 10 lb. to about 50 lb. for every $\frac{1}{8}$ inch of elongation. Their respective effects were afterwards reduced to a value per square foot. The instrument was generally placed so as to be immersed at about three-fourth tide, and in such situation as would afford a considerable depth of water. It is not desirable to have the instrument placed at a much lower level, as it has not unfrequently happened during a gale, that for days together no one could approach it to read off the result and re-adjust the indices to zero. It must, however, at the same time be remarked, that it is in most situations almost impossible to receive the force unimpaired, as the waves are more or less broken by hidden rocks or shoal ground before they reach the instrument.

In 1842 several observations were made on the waves of the Irish Sea at the Island of Little Ross, lying off the Bay of Kirkcudbright. Since April, 1843, till now, continued observations have been made on the Atlantic at Skerryvore, and neighboring rocks, lying off the Island of Tyree, Argyllshire. And in 1844 a series of similar observations was begun on the German Ocean at the Bell Rock. It will be seen, that in selecting these localities a varied exposure has been embraced, comprising the comparatively sheltered Irish Sea, the more exposed eastern shore of Scotland, and the wild rocks of Skerryvore, which are open to the full fury of the Atlantic, the far distant shores of North America being the nearest land on the west.

In the *Atlantic Ocean*, according to the observations made at Skerryvore rocks, the average of result for five of the *summer* months during the years 1843 and 1844, is 611 lb. per square foot. The average results for six of the *winter* months (1843 and 1844,) is 2086 lb. per square foot, or thrice as great as in the summer months.

* The plate or disk of the Marine Dynamometer is intended to represent in the circumstances of its exposures, stones or other obstacles to which the sea has access on every side, which is the case in all dry stonework, of which harbors and breakwaters are commonly composed, as also open pilework of every kind. It may also be observed that by the time that the crest of the wave (if unbroken) has proceeded so far as to be above the disk, the instrument will have registered its maximum, although that maximum will probably be to some extent affected by the statical pressure on the side of the disk next C C. But the experiments have reference solely to bodies immersed in water.

The *greatest result* yet obtained at Skerryvore was during the heavy westerly gale of 29th March 1845, when a pressure of 6983 lb. per square foot was registered. The next highest is 5323 lb.

In the *German Ocean*, according to the observations made at the Bell Rock, the greatest result yet obtained is 3013 lb. per square foot.

It thus appears, that the greatest effect of the sea, which has been observed, is that of the Atlantic at Skerryvore, which is nearly equal to three tons per square foot.

These experiments, amounting to 267 in number,* and on the Atlantic alone extending over 23 months continuously, are not intended to prove anything farther than the simple fact, that the sea has been known to exert a force equivalent to a pressure of three tons per square foot, however much more.

Ascertained effect of Waves.—I shall now contrast the indications of the Marine Dynamometer by stating a few facts regarding the ascertained effect of the waves in the elevation of spray, and in the transportation of heavy masses of rock. In the first instance, to give some idea what may be looked for in comparatively small expanses of water, such, for instance, as the lakes of North America, which, however, exhibit during gales of wind, all the characteristics of an open sea. In the north-eastern corner of LAKE ERIE the HARBOR OF BUFFALO was constructed at a cost of about 40,000*l.* It is mentioned in the "Civil-Engineering of North America," that the author "measured (at this harbor) several stones which had been moved; and one of the largest of them, weighing upwards of half-a-ton, and had been completely turned over, and lay with its bed or lower side uppermost." In the FIRTH of FORTH, at the GRANTON PIER works, on the 19th December 1836, after a gale from the north-east, one stone was moved measuring fifteen cubic feet, or about one ton in weight, and thrown on the beach, after having been built into the wall; and a stone containing eighteen cubic feet was moved thirty feet from its place; while the *pierres perdues* or mound-stones were washed down to a slope of about 4 to 1. The following instance, which occurred at the landing slip of the Calf Point, ISLE OF MAN, affords a proof of the great force of the waves even in the Irish Sea. During a gale from the north-west, a block was lifted from its place in the wall and thrown landwards, which measured 123½ cubic feet, equal to about 10 tons weight. At the island called the Barrahead, one of the Hebrides, a remarkable example occurred during a storm in January 1836, in the movement of a block of stone, which, from measurements taken on the spot, is 9 feet × 8 feet × 7 feet = 504 cubic feet, which, allowing 12 feet of the gneiss rock to the ton, will be about 42 tons weight. This great mass was gradually moved 5 feet from the place where it lay, having been rocked to and fro by the waves till a piece broke off, which rolling down, and jamming itself between the moving mass and the shelving rock on which it rested, immediately stopped the oscillatory motion, and thus prevented the farther advance of the stone.

*It was not thought necessary to give all the observations in the table appended to this paper.

Experiments.—With reference to the following experiments I have only to observe, that those which were made at Little Ross, upon the Irish Sea, cannot, from the unusual fineness of the weather at the time, be regarded as affording a true value of the effects of a hard gale in these seas. Of the others it is to be noticed, that where two or three instruments were for some time employed as a check upon each other, and only one or two readings are given, the want has occurred either from the instruments being under repair, or being difficult of access in stormy weather, or during neap tides. It often happened also, in consequence of the springs proving too weak, when new ones had to be made, or the area of the disk reduced. Registers of the state of the weather, apparent height of spray, &c., were generally kept; but it was not considered necessary to complicate the Tables by inserting these, excepting in one or two instances.

Observations at the Skerryvore Rock, and the neighboring Island of Tyree, distant 13 *miles from the Skerryvore are as follows:*

TABLE I.

Dates.	lbs. to a Square Foot.	Dates.	lbs. to a Square Foot.
1843.		1843.	
April 24	455	Aug. 22	723
May 7	243	Sept. 5	866
" 16	364	Oct. 5	1535
June 3	182	Nov. 18	1711
" 9	173	" 29	2353
July 2	476	Dec. 8	3421 at least
" 30	433		
Aug. 9	346	" 14	2460
1844.		1844.	
Jan. 28	3313	June 15	1828
Feb. 2	429	July 11	1028
" 3	429	" 23	1532
" 15	312	" 27	457
" 24	1284	Aug. 1	571
" 26	2032	" 30	1713
March 4	3316	Sept. 12	1028
" 10	1925	" 20	457
" 12	3316	" 25	685
" 13	1142	Oct. 2	2399
April 10	457	" 11	3427*
" 14	571	" 22	800
" 17	800	Nov. 2	1942
" 19	800	" 16	2056
" 24	1949	" 23	3427
" 30	222	Dec. 9	2738
May 15	343	" 10	1825

*On this occasion, 14 stones were slightly moved, and 14 scattered, all of which had been built into the round-head or end of Hynish Pier, which was still in an un-

A more exposed point of the Skerryvore Rock was chosen for the experiments of the second table; and with the view of ascertaining the effect of the waves at different heights upon the rock, two instruments were fixed, the one (No. I.) several feet lower, and above 40 feet seaward of the other (No. II.) It was observed, that about half-flood the waves were a good deal expended before they reached the place where No. I. was placed, from their being so little water on the rocks outside. Whereas when the tide was higher the waves were, from the greater depth of water, not so much broken when they reached No. II. The results of the Marine Dynamometer show generally about twice the force at No. II. as at No. I.; a result which shows how important it would be to ascertain the relative forces of the waves at different levels upon our breakwaters and other sea-works.

TABLE II.

Date.	Remarks.	Pressure in lb. per Ft.	
1845.		I.	II.
Jan. 7	Heavy sea . . .	1714	4182
" 16	Heavy ground swell .	2856	4752
Feb. 5	Fresh gales . . .	856	3042
" 24	Fresh breezes . .	1256	3802
March 11	Short sea . . .	1028	
" 29	Strong gale, the highest waves supposed 20 feet high, and the spray 70 feet. ,	2856	6038

Trans. of the Roy. Soc. of Edinburg.—Civ. Eng. and Arch. Jour.

Report of the Board of Engineers of the U. S. Navy, on Hunter's and Loper's Propellers.

WASHINGTON, D. C., Jan. 31, 1846.

SIR—Your letter of the 23d inst. is received. In reply to the several inquiries respecting the proposed alterations in the U. S. Steamer "Union" of the 18th June last, and the 16th inst. we have the honor to

REPORT:

1st. That, "If the cylinders of the 'Union' should be increased as proposed by Mr. Haswell, 18th June, 1845, what addition would it make to the cost of the other alterations of that vessel, as proposed by Messrs. Haswell, Copeland & Faron, in their report of the same date, and what additional delay would it occasion in completing her steam arrangements?"

finished state, and a Dynamometer which was attached to the Pier, registered on this occasion 2557 lbs. These stones weighed from 1 to 1·33 tons, and exposed, when built into the wall; about 2 square feet of surface. The stone to which the instrument was fixed was turned upside down, although it weighed 1¼ ton=2800 lb.

The additional cost for them would be about eighteen hundred dollars, ($1800) and as they could be made and fitted within the time necessary for the alterations or repairs of the propellers, their adoption would not add to the time necessary for the completion of the steam arrangements of this vessel.

2d. The "advantages that might be expected from such enlarged cylinders, in consumption of fuel, increase of speed or durability of boilers," are, in the consumption of fuel, none worthy of noting, in the increase of speed, an average increase in the number of revolutions of the engines per minute of one revolution, (other things being equal;) and in the durability of the boilers, of the extension of their probable duration for the additional period of two years.

3d. The "additional cost and the particular advantages of adopting the alterations and additions to the engines, as proposed by the Engineers on the 18th inst., over those proposed in June, including Mr. Haswell's separate propositions, and on the supposition that the present *form* of the propeller is to be retained"—would be, for the cost twenty-one hundred dollars, ($2100) and the advantages, the benefit of the force of the *vacuum* about 10 lbs. per square inch in average effect, the dispensing with the noise of the exhausted steam, and of the exposure of position to an enemy by the escape of a vapory cloud, an economy in the consumption of fuel with equal power of engine from the addition to the power acquired by the vacuum, and the increased period of duration of the boilers as before mentioned; further, the proposed condensers, air pumps, &c. could "be placed in the space now occupied by the engines and dependencies."

4th. The "estimated advantages of the condensing engines, as proposed on the 16th instant, over the proposed arrangements as made in June, with Mr. Haswell's proposals combined—if applied to Mr. Hunter's propellers, with half the paddles removed, and the fillings between them taken out"—are the attainment of the vacuum and the increased duration of the boilers. The alteration of the propellers in their construction, would in nowise affect the value of these replies, provided the propellers were not rendered less efficient; for, if so, the consumption of fuel would be increased to acquire a speed of vessel equal to that already attained, and contrariwise.

5th. The data from which the estimates were made, and by which "we calculated the increase of speed and saving of fuel which would be gained by adopting the proposed alterations suggested on the 16th instant, instead of those proposed in June last," are herewith furnished and designated respectively A & B.

The first (A) comprises the elements of comparison of the relative effects and values of Hunter's and Loper's propellers, as furnished by Captain A. V. Frazer in his reports of the performances of the U. S. Revenue steamer "Spencer," with the former propeller, in September, 1844, and with the latter in May 1845, the deductions from which show that the capacity of Loper's propeller compared with Hunter's, in the attainment of speed, is in the ratio of 4.5 to 1, and that when

the element of the consumption of fuel is considered, the value of it in this case is increased to 6.72 times.

The second (B) comprises the elements for a similar comparison, furnished by a report of the performance of the U. S. steamer "Water Witch" in May, 1845, when that vessel was fitted with "Hunter's" propellers, and by a subsequent one regarding a performance of this same vessel in December last, when fitted with other engines and "Loper's" propellers.

The standard of comparison in both instances is the performance of the U. S. steamer "Engineer," which vessel was run in company, and the times of running the two vessels accurately noted. It is here assumed, other things being equal, that the revolutions of the water wheels of the "Engineer" are a true measure of her relative speed at all times, and that the result of their reduction to correspond with the speed of the "Water Witch," on each occasion, is also a true measure of the relative speed of that vessel.

The draught of water of the "Water Witch" in the first trial was 7 feet 7½ inches, and in the second 6 feet 2 inches. The hull of this vessel at the time of the alterations in her engines and propellers was lengthened near the centre, 30 feet, and her beam increased 6 inches. The resistance due to the additional length and beam, in our opinion, somewhat exceeds the advantage due to the difference in draught of water in these trials.

In the absence of reliable information of the actual consumption of fuel in each trial of this vessel, we assume it to be in the ratio of the area of the grate surface, and when the construction of the boilers, the similarity in the mode of promoting combustion (that of the exhaust steam being led into the smoke pipe) are duly considered, we are confident in the expression that the comparison is a just one. The results of this comparison show that "Loper's" propeller is more effective than "Hunter's" in the attainment of speed, being in this application 3.7 times greater; and when the consumption of fuel is considered, it has 5.56 times the commercial value.

Further, the proportion of these "advantages assigned to the change of propellers" is the full difference of two miles per hour, and the advantages due, "to the change of the engines, &c." are, that by a reduction of the pressure in the boilers, this advantage of speed may more readily be obtained at an uniform rate, and not as heretofore subjected to the mutations consequent upon a range of pressures of double the extent of that which would be consequent upon the adoption of the alteration proposed.

Statement C. shows the results effected by a change in the number of buckets of "Hunter's" wheel, as reported to Col. J. J. Abert, Chief of the Topographical Corps, by Capt. Wm. G. Williams, T. E., September, 1844, from experiments made with the United States steamer "Abert."

From which it appears that a removal of each alternate bucket enabled an additional speed of 1·2575 miles per hour to be obtained,

even with an increase in the draught of water of the vessel of 2¼ inches in depth.

A.

Comparison of the effects and values of "Hunter's" and "Loper's" propellers, based upon a report of Capt. A. V. Fraser, of the performances of the United States Revenue steamer "Spencer," in September, 1844, and May, 1845.

With "Hunter's" Propeller.

Average pressure of steam by safety valve 77.5 lbs., which increased by one atmosphere (14.7 lbs.) is equal to 92.2 lbs. per square inch—cut off at one-third of the stroke of the piston (3 feet) gives by the formula,

$$\text{hyp: log:}\frac{\text{Length of stroke of piston.}}{\text{Distance at full stroke.}} + 1 = \text{ratio of uniform force.}$$

$$\text{or hyp: log:}\frac{3}{1} = 1.0986 + 1. = 2.0986. \text{ then}$$

$\frac{2.0986}{3} \times 92.2 = 64.5$ lbs., from which deduct 14.7 lbs. for the atmospheric resistance, and 49.8 is the mean pressure on the piston.

Average number of revolutions 53.5 per minute.

Fuel consumed 2760 lbs. of anthracite coal per hour.

Average speed attained 6.5 miles per hour, the effect of which is measured by its cube, and is equal to 274.6.

With "Loper's" Propeller.

Average pressure of steam by safety valve 49.09 lbs., which increased by one atmosphere is equal to 63.79 lbs. per square inch. Cut off at one-half the stroke of the piston, gives, by the preceding formula, a mean pressure of 39.3 lbs. on the piston.

Average number of revolutions per minute 44.45.

Fuel consumed 1210 lbs. of anthracite coal per hour.

Average speed attained 9.32 miles (erroneously printed 9.29) the cube of which is 809.5.

Let P, represent the pressure.

r, the revolutions per minute.

f, f', the fuel per hour.

t, the time of consuming fuel, which is inversely as the speed.

S^3 S'^3, the cubes of the speed.

Pr. will give the power exerted by each engine.

Pr. S'^3, the useful effect of one, and by inversion Pr. S^3, the useful effect of the other application.

$t f$, the cost of the relative effects for a given distance.

and $\frac{S'^3 f}{S^3 f'}$ = useful effect combined with the cost, or the commercial value.

Hunter. Pr. = 2664.3 — 1
Loper. Pr. = 1746.8 — or — .655 — power.

Hunter. Pr. S^3 = 179.5 — 1
Loper. Pr. S'^3 = 809.5 — or — 4.5 — useful effect.

Hunter. $t\,f$ = 9.32 × 2760 — 3.27
Loper. $t\,f'$ = 6.5 × 1210 — = — 1 — cost of effect.

Hunter. $S^3 f'$ = 332266 — 1
Loper. $S'^3 f$ = 2234220 — = — 6.72 — value.

Shewing, that with equal powers, that "Loper's" propeller has 6.72 times the value of "Hunter's."

NOTE.—The friction of the engines proper has not been introduced, as it is here considered a quantity bearing a constant ratio to the power exerted.

There was some difference existing, however, against the results of the performance of "Loper's" propeller, as the engines are connected to the propeller shafts, through the medium of bevel wheels, while in the other case they were directly applied.

B.

Comparison of the effects and values of "Hunter's" and "Loper's" propeller, based upon the performances of the U. S. Steamer "Water Witch" in May and December, 1845, as reported by the officers detailed for this duty.

"Water Witch."

With "Hunter's" Propeller.	With "Loper's" Propeller.	
Let a	a'	represent area of cylinder.
P	P'	" average pressure in boiler per sq. in.
p	p'	" average pressure in cylinder per sq. in.
v	v'	" velocity of piston in feet per minute.
T	T'	" time of running.
g	g'	" area of grate surface in square feet.

"Engineer."

Let r	r'	represent average revolutions per minute.
t	t'	" time of running.
and x	x'	" power exerted for an *unit* of effect produced in each trial of the "Water Witch."
y		" the relative *useful effect.*
z		" this effect with the consumption of fuel considered, and we have the *relative values.*

Thus, for the useful effects, and by the following formula:

1. $$\frac{a\,p\,v}{\left(\frac{t\,r}{\mathrm{T}}\right)^3} = x$$

2. $$\frac{a'p'v'}{\left(\frac{t'\,r'}{\mathrm{T}'}\right)^3} = x'$$

$$\text{or } \frac{x}{x'} = y$$

And for the relative values:

3. $$\frac{g}{g'} \times \frac{\left(\frac{r'\,t'}{\mathrm{T}'}\right)^3}{\left(\frac{r\,t}{\mathrm{T}}\right)^3} = z.$$

NOTE.—The number of engines in both trials was two, and the steam was uniformly cut off at one half of the stroke of the piston.

Substituting known values for these symbols—

a =	380 sq. inches	a' =	314 sq. inches.
P =	77 pounds	P' =	52.5 pounds.
p =	63 pounds	p' =	42.2 pounds.
v =	214 feet	v' =	276 pounds
T =	51.5 minutes	T' =	24.5 minutes.
g =	60 square feet	g' =	28.5 sq. feet.
r =	21 per minute	r' =	26.4 per minute.
t =	45 minutes	t' =	23.5 minutes.

We have by formula—

1 $$\frac{380 \times 63 \times 214}{\left(\frac{45 \times 21}{51.5}\right)^3} = \frac{5123160}{6128} = 836 = x.$$

2 $$\frac{314 \times 42.2 \times 276}{\left(\frac{23.5 \times 26.4}{24.5}\right)^3} = \frac{3657220}{16194} = 225.8 = x.$$

$$\frac{836}{225.8} = 3.7 = y.$$

3 Then $$\frac{60}{28.5} \times \frac{16194}{6128} = \frac{971640}{174648} = \frac{5.56}{1} = z.$$

Shewing that in this application "Loper's" propeller has 5.56 times the commercial value.

C

Results of trials with "Hunter's" propeller, in the U. S. steamer "Abert," when fitted with 16 buckets in each propeller, and when that number was reduced one half; furnished by a report of Captain Wm. G. Williams, T. E., to Col. J. J. Abert, Chief U. S. Topographical Bureau, September 30, 1844.

With Sixteen Buckets.

Average revolutions of propellers per minute,	59.5
Average speed attained,	5.975 miles.
Mean draught of water,	5 feet 3½ inches.

With Eight Buckets.

Average revolutions of propellers per minute,	58.875
Average speed attained,	7.1875 miles.
Mean draught of water,	5 feet 5¾ inches.

Then—to ascertain the speed with sixteen buckets due to the revolutions with eight buckets.

$$\frac{5.975}{59.5} \times 58.875 = 5.93 \text{ miles per hour.}$$

and 7.1875—5.93=1.2575 miles gained by the alteration, with an increased draught of 2¾ inches.

We are, respectfully, your obedient servants,

CHAS. H. HASWELL, *Eng. in Chief, U. S. N.*
CHAS. W. COPELAND, *Naval Engineer.*
JOHN FARON, JR., *Chief Engineer, U. S. N.*
A. HEBARD, *Chief Engineer, U. S. N.*

To COMMODORE CHAS. MORRIS, *Chief of Bureau of Const., Equip. and Repair.*
Washington, D. C.

SPECIFICATIONS OF ENGLISH PATENTS.

Specification of the Patent granted to JAMES JOHNSTON, *of Willow Park, Greenock, for New and Improved Processes and Machinery for Making and Refining Sugar.*—Sealed January 31, 1845.

To all to whom these presents shall come, &c., &c.,—

A sirup made from double refined loaf sugar is perfectly free from coloring matter, yet if it be for a short time exposed to excessive heat it becomes dark, and will not again crystalize, or if it be long exposed to gentle heat the same result occurs. Now in either case the coloring matter produced was not a substance foreign to the sugar; it was a part of the sugar that was actually converted into coloring matter.

Sugar refiners in making use of large-sized vacuum pans overlook the fact, that they become color manufacturers when they keep their saccharine fluids long exposed to the action of gentle heat. In these large pans the saccharine fluids are kept longer under the influence of heat than they are when boiled in small pans.

The sum and substance of the invention which I am about to describe in detail is, that I have invented an apparatus by which saccharine fluids may be evaporated sufficiently for crystalization with only a few minutes exposure to heat. In my vacuum pan there need not be inserted at one time more than fifty pounds weight of saccharine fluid, and yet a large business in sugars may be done with this small apparatus, as there is no time lost in filling or emptying it, as the vacuum is never injured either by the letting in or withdrawal of the charge from the pan.

The first part of my invention I shall describe is an apparatus by which vacuum pans may be emptied without the vacuum being destroyed.

I attach a pipe to the bottom of a vacuum pan, so that the saccharine fluids within the pan can freely enter the pipe, and the pan may be emptied thereby. I call this the barometer pipe; it must be made of such length that the weight of the saccharine fluid within it shall counterbalance or rather exceed the weight of the atmosphere, so that when a stopcock at the bottom of the pipe is opened, the saccharine fluid within the pan will, of its own weight, rush out by the pipe till the pan is emptied; but the pipe will remain filled with the saccharine fluid in the same manner as a common barometer tube remains full of mercury. The pipe for this purpose will be upwards of twenty-five feet long; the length of the pipe required depends on the specific gravity of the saccharine fluids after they are boiled; the heavier the fluids the shorter the pipe may be made.

The proceeding is the least expensive method of emptying a vacuum pan without destroying the vacuum; but as it may not always be convenient, instead of the barometer pipe, a pump may be attached to the pan, for the purpose of removing the saccharine fluids without destroying the vacuum; but I prefer the barometer pipe when it can be conveniently used.

I claim the making and using of vacuum pans with apparatus attached, so that the contents of the pans may be withdrawn without the vacuum within the pans, being destroyed.

Second part of my invention. All liquids, but especially thick saccharine fluids, are most easily evaporated when distributed in thin strata. For the purpose of carrying out this system of evaporation several machines have been contrived; the earliest invented was Mr. Cleland's, described in his patents, of 17th August, 1822, and 6th of May, 1824; also Mr. Aitchison's inventions, patented 15th September, 1829, and 24th June, 1840.

As I have invented an apparatus for the same purpose, I shall describe the difference between it and those that have already been made public.

Mr. Aitchison's apparatus consists of a hollow cylinder of copper, heated internally by steam. It is made to revolve in a trough, containing a quantity of saccharine fluid; the lower half of the cylinder being immersed in the fluid, when the cylinder is set in motion a thin layer of fluid goes round with it. It is this distribution of the fluid

on the surface of the heated cylinder which causes the rapid evaporation.

Mr. Clelend in his invention used a spiral heated coil of pipe, instead of the cylinder employed by Mr. Aitchison.

The sugar made by Mr. Aitchison's apparatus is superior in color, size, and hardness of crystal, to that produced by the vacuum pans; but the misfortune with the inventions of Messrs. Cleland and Aitchison is, that a large business in sugars cannot be done with them, owing to the loss of time occasioned by the necessity of frequently filling and emptying the troughs.

I obtain a thin strata of fluid on a heated metallic surface, by causing a stream of the fluid to run down an inclined plane heated by steam. For the sake of explanation, suppose a flat table of twenty feet in length and two feet broad, made of two thicknesses of metal, so that steam may be made to pass through internally from end to end and heat the table; also, that the pipes which convey the steam to the interior of the table be flexible or jointed, so that one end of the table may be elevated at pleasure. When one end is raised, this table will serve as an inclined plane, on which, to cause a thin stream of saccharine fluid to run from the upper to the lower end, and in so doing, the fluid will be evaporated, owing to its being made to run over the heated surface. The long sides of the table or plane must be provided with raised edgings to prevent the fluid running off at the sides. The thickness of the strata, or quantity of fluid, made to pass along the inclined plane is adjusted by a stopcock on the pipe (connected with a cistern), which lets on the fluid at the top of the plane. At the lower end of the plane the concentrated fluid runs into the coolers without interruption; when one cooler is filled the concentrated fluid may be directed into another without any stoppage of the evaporating process, and consequently there is no loss of time in working the inclined plane. The degree of concentration of the fluid is obtained according to the degree of inclination at which the plane is set. When the plane is set with very little inclination the fluid will take longer time to go from the high to the low end, and consequently it will be denser, as it is longer exposed to the heat.

After these inclined planes have been used for some time on the large scale, the sugar refiners will find out by experience the angle of inclination which answers best, and will be able to do away with the flexible pipes and the necesssity for altering the angle of inclination of the plane; they will then regulate the degree of concentration of the saccharine fluids by the quantity of fluid let on to the plane in a given time, and by the degree of heat applied to the plane during that time.

I do not confine myself to any particular dimensions or kind of material used in the construction of the inclined planes, but cast-iron or copper are the most suitable. Steam, hot air, or any other heating medium may be employed to heat the planes.

I claim the evaporating of saccharine fluids by distributing them in thin strata, when the said thin strata is obtained by causing the saccharine fluids to run by their own weight from the high to the low end of heated inclined surfaces, whether curved or plain.

The third part of my invention which I claim is, a combination of the first and second parts of my invention, described as follows:—

The second part of my invention consists of an apparatus for the evaporation of saccharine fluids whilst exposed to the pressure of the atmosphere.

Now, it is quite evident, that the thin strata of fluid whilst flowing along the inclined plane would be still more quickly evaporated if the pressure of the atmosphere could be kept off it. For this purpose, I propose to cover the inclined plane with a strong metallic arched covering that will be able to resist the pressure of the atmosphere.

Suppose this to be done, and a communication by means of pipes be made between the covering on the inclined plane and the vacuum pump of a sugar house. A vacuum may now be formed in the space between the inclined plane and the covering. The thin strata of saccharine fluid running along the inclined plane will now be in a vacuum and its evaporation accelerated thereby. But the working of an apparatus like this could not be carried on any length of time without interruption, for the stream of saccharine fluid let on to the inclined plane would very soon fill up all the space between the covering and the plane, and the apparatus would be rendered useless for the time being. It is therefore necessary that some provision be made by which the concentrated fluid may be withdrawn from the plane without the vacuum being destroyed. This I propose to do by attaching to the lower end of the plane a pump, or the barometer pipe already described.

With an apparatus constructed like this, the process of concentrating saccharine fluids may be carried on without interruption for any length of time, as the supplying of the fluid through a pipe and stop-cock at the high end of the plane, or the withdrawal of the concentrated fluid by the barometer pipe at the lower end of the plane will cause no interruption to the vacuum, or process of evaporation, and the saccharine fluid is only a short time exposed to the action of heat; for the whole of it on its passage along the plane is exposed in thin strata; whereas, in any other apparatus that has yet been invented for the evaporation of saccharine fluids there is always a large mass of the fluid kept in a heated state, which is not in contact with the vacuum where the most rapid evaporation takes place. For instance, in the vacuum pans, the whole contents are kept heated, whereas, only one part out of a thousand of the heated fluid is actually in contact with the vacuum.

Evaporation in vacuum pans is produced by two causes.

First, the evaporation by vacuum.

Second, the evaporation by heat.

To increase the heat evaporating power of a pan it is necessary to increase the amount of surface of heated metal in contact with the fluid to be evaporated.

To increase the vacuum evaporating power of a pan it is necessary to increase the amount of surface of the liquid that is exposed to the vacuum.

The two causes of evaporation are quite distinct, but in order to

prevent any misunderstanding be it understood, that when a sugar refiner inserts a number of steam pipes through the mass of saccharine fluid laying in a vacuum-pan he is subdividing the fluid for the purpose of bringing it more intimately in contact with the heating surface, but he does not thereby bring it more intimately in contact with the vacuum surface.

I claim the invention of exposing to the influence of a vacuum, saccharine fluids in a state of minute division, or thin strata for the purpose of bringing a large amount of the surface of the fluid in contact with the vacuum.

Fourth part of my invention—When filtering saccharine fluids sugar refiners pass them through cotton or woollen bags, in order to remove the particles of extraneous matters that are mechanically suspended in them; they then pass the fluids through beds of animal charcoal, in order to remove the coloring matters chemically incorporated with them.

Instead of the bags for removing the mechanically suspended coloring matter, I claim the passing of saccharine fluids through beds of mineral substances, unprepared, such as sand or earths, or through prepared minerals, such as potters' refuse, unglazed earthenware, or pounded bricks.—*Enrolled July* 31, 1842. Lon. Jour. of Arts & Sci.

Specification of a Patent granted to Arthur Varnham, *of the county of Middlesex, stationer, for improvements in the manufacture of paper, in order to prevent fraud, which he intends to call safety and protective paper.*—[Sealed 4th February, 1845.]

The safety and protective paper consists of a colored or test sheet of paper, covered with a white or delicately colored sheet on one or both sides.

The following is the mode of manufacturing paper, of the description termed hand-made paper, according to this invention:—The rags for the colored or test paper, after being reduced to "half stuff," and bleached, if necessary (being, in this case, carefully deprived of the bleaching liquid), are introduced into the beating engine, which should have steel or brass bars and fittings, according to the color required for the test paper. When the engine is "half beat," the coloring matter is to be added; the engine is then reduced to pulp, and emptied into a chest, which is called No. 2. The coloring matter is prepared with great care in vessels of glass, or earthenware, to prevent the delicacy of the color being impaired; it may consist of any coloring matter usually employed for coloring paper, and also of all others susceptible of change from chemical action. The rags for the outer sheet, or sheets, which are to be of a more tender kind, after being reduced to half pulp, and bleached, if necessary, are introduced into the beating engine; and if the paper is to be engine-sized, a resinous size is added to the pulp, together with a small quantity of alum. When reduced to pulp, the engine is emptied into a chest called No. 1; and if a delicate color is to be given to the outside sheet or sheets, the color

is then added to the pulp. Two vats Nos. 1, and 2, are employed in the manufacture of this paper, being supplied with pulp from the chests Nos. 1, and 2. The vat-man first makes a white or delicately colored sheet, on a suitable mould, from vat No. 1, and delivers it to the coucher, who couches it on the first or bottom felt; the vat-man then makes a colored sheet, on a mould of the same size and form, from vat No. 2, and delivers it to the coucher, who couches it on the white or delicately colored sheet, and then places a felt upon it; but if the test sheet is to be covered on both sides, another sheet is made from vat No. 1, and couched on to the test sheet, previous to placing the felt thereon. The vat-man and coucher continue to work in this manner until a post of felts is completed; and after the post has been well pressed, the pack-pressing, parting, drying, and sizing (if necessary), are performed in the usual manner.

The mode of making this paper by machinery is as follows:—The two descriptions of pulp, prepared in the manner described for hand-made paper, are caused to flow from the chests into the servers, thence simultaneously on to the wires attached to them, and proceed onwards to the marking dandy, and from it to the couch rolls, where the test sheet and the white or colored sheet or sheets unite, and form one sheet; this sheet then passes on to the felt, and is pressed, dried, and finished, in the usual way.

The patentee states, that he claims, as his invention, "a white sheet or surface on one or both sides of the test or colored sheet; or a more delicate colored sheet or surface than the test sheet on one or both sides of the test or colored sheet."

The object of this invention is to prevent paper from being tampered with by chemical agents, or acted on by a sharp instrument or rubber, for the purpose of erasing any writing which may be thereon. If a chemical agent be employed, the test sheet will be so changed as to alter conspicuously the former appearance of the paper, and the white or pale-colored sheet or sheets will be imbued with a stain or color, produced by the action of the chemical agents on the test sheet; and it will afterwards be impossible to make the paper assume its original appearance: for if an attempt be made to whiten or renew the delicate color of the outer sheet, the appearance of the test sheet will be destroyed; or, if an attempt be made to color the test sheet, a darker color will likewise be produced on the outer sheet. In the event of a sharp instrument or rubber being used, then, at the places where a figure or word has been obliterated, the test paper will appear conspicuously; and the paper cannot be restored to its original appearance.—*Inrolled August* 1845. Ibid.

Specification of a Patent granted to George Brown, *of Glasgow, Scotland, merchant, for certain improvements in the manufacture of soda,—being a communication.*—[Sealed 20th February, 1845.

The object of this invention is to transform the sulphuret of sodium, produced in the manufacture of soda, into sulphate, sulphite, or hy-

posulphite of soda, and so make soda free from those impurities which render it less fit than it otherwise would be for soap-making, bleaching, and other uses. The patentee proposes to effect this by fluxing the soda, containing sulphuret of sodium, with a sufficient quantity of nitrate, chlorate, or chlorite of soda, or other body possessing an oxidizing power; but, in most cases, he prefers to use the nitrate of soda.

One mode of carrying this invention into effect is as follows:—The liquor drawn from crude soda is boiled down in a pan or furnace, until about four-fifths of the salt are precipitated; the whole is then removed from the furnace, and the wet, pasty salt allowed to remain for some time in a vessel to drain; by this means the greatest proportion of the liquor that remained in the mass (commonly known as red liquor) will be separated from it. The red liquor (which consists chiefly of caustic soda and sulphuret of sodium, with a certain proportion of neutral salts, such as sulphate of soda and common salt) is put into a metal pan, and evaporated to about the consistency of tar; then the proper quantity of nitrate of soda is added, and heat applied to expel the remaining water, and flux the mass. The application of heat causes copious fumes of ammonia to be exhaled, and the mass froths and bubbles up, which serves as a guide to the operater in adding the nitrate of soda; as when no ebullition is produced by the addition of a fresh portion of nitrate of soda, it is a proof that the proper quantity has been added. When the mass is brought to a quiet flux, it is run into moulds; and when removed therefrom, is ready for use.

Another mode of proceeding is, to boil down the whole quantity of crude soda liquor; and during the boiling, when the liquor is brought to about the consistency of tar, to add the nitrate of soda, or other oxidizing body; and, the evaporation being completed, flux the soda containing the sulphuret of sodium.

The patentee claims, as his invention, the improvement in soda-making by fluxing the soda, containing sulphuret of sodium, with bodies possessing an oxidizing power.—[*Inrolled August*, 1845.]

Ibid.

Specification of a Patent granted to WILLIAM TRUEMAN YULE, *of the county of Middlesex, preserved provision manufacturer, for improvements in preserving animal and vegetable matters.*—[Sealed 28th January, 1845.]

The first part of this invention consists in drying animal and vegetable matters, when preserving the same, by passing over them a current of air, which has been previously dried by passing it through calcined chloride of calcium or other chemical absorbent of moisture.

The animal and vegetable matters to be preserved may be either in a cooked or uncooked state; they are hung up in a chamber of an oblong form, or placed on shelves therein, and are subjected to the action of a current of air, which has been dried by passing through cal-

cined chloride of calcium. The chloride of calcium is broken into pieces about the size of a walnut, and placed in a vessel with a grating at the bottom, through which it flows as it becomes dissolved, into a receptacle below; and the dissolved portion being evaporated to dryness, and calcined, is again placed at the top of the vessel. The vessel containing the chloride of calcium may be placed between the chamber and the air-pump used for producing the current of air, so that the air will be forced through the chloride of calcium, and then through the chamber; or the air-pump may be situated at the other extremity of the chamber, so as to draw the air through the chloride of calcium, and then through the chamber.

The second part of the invention consists in keeping animal and vegetable matters dry, when preserving them in closed vessels, by placing chloride of calcium or other chemical absorbent in such vessels, but not in contact with the matters to be preserved.

It is well known that chloride of calcium possesses a great affinity for water; and that the decomposition of animal or vegetable matters takes place much more slowly in a dry than in a moist atmosphere. The patentee takes advantage of these properties to preserve for a long time such animal or vegetable matters as have already been more or less perfectly dried, or more or less perfectly preserved with an antiseptic, such as hams, tongues, cheese, dried fruits, vegetables, &c.; and the plan he adopts is to put them in air-tight vessels or cases along with the chloride of calcium. The cases are preferred to be made of tin; and it is considered advantageous to create a partial vacuum therein, by means of an air-pump, when the animal or vegetable matters are very moist. The quantity of chloride of calcium used, is generally one-tenth of the weight of the substances so be preserved; but this proportion is varied, according to the state of dryness of the substances when put into the case. The chloride of calcium is broken into pieces of about the size of a walnut; and, in packing the cases, it is wrapped up, in quantities of about one pound, in blotting paper or calico, and put in with the articles to be preserved; and the interstices between these articles are filled with husks of corn.

If the animal or vegetable matters have not been dried, the air is exhausted from the cases, and a larger proportion of chloride of calcium is used, say about three or four times the weight of the substances.

The patentee claims, Firstly,—preserving animal and vegetable matters by drying the same by the aid of streams of air, dried by chemical means, as herein described. Secondly,—preserving animal and vegetable matters in closed vessels, by drying, and keeping them dry, by means of chloride of calcium or other similar chemical absorbent.—[*Inrolled July*, 1845.] Ibid.

MECHANICS, PHYSICS, AND CHEMISTRY.

On Staining Glass. By Professor Schubarth.

Mode of Obtaining a Red Color by means of Oxide of Copper.—The ancients were acquainted with the means of staining glass by the employment of oxide of copper; it is mentioned by Neri and Kunckel, in their works. The art was however so completely lost at the close of the last century, that it was generally believed that glass was always stained red by means of Cassius purple. It was not until 1828 that M. Engelhardt, of Zinsweiler, succeeded in staining glass red by means of a mixture of equal parts of oxide of copper and protoxide of tin: this process was tried with success in the glass manufactory at Hoffurmgsthal, Silesia.

The protoxide of tin is now done away with, and the compound employed is nearly the same as that mentioned by Neri, but more simple. It is composed of a mixture of copper scales (which are almost entirely composed of oxide), and oxide of tin (*zinnasche*) obtained by the oxidation of that metal in a state of fusion in contact with the air, to which a small quantity of iron filings is sometimes added, when a scarlet tint is required to be produced. Should the color by accident disappear, it may be brought out by again bringing the copper into the state of oxide; this is done by introducing into the vessel a small quantity of tin or iron scale. It will of course be understood that the glass to be operated upon must not contain saltpetre, nor any other oxidizing substance.

Glass stained by means of oxide of copper is of a very deep color, and can only be worked in thin sheets, and by covering it with a thick colorless glass (plate glass.)

Obtaining a Red Color by means of Gold.—The employment of gold for staining glass red does not appear to have been known to the ancients, and the period when it was first used, and by whom, cannot be ascertained. In the seventeenth century Kunckel employed Cassius purple for staining glass a ruby color; this was discovered by A. Cassius a short time previous; but the recipe employed by Kunckel was not generally known until it was published in 1836, by M. Metzger, proprietor of the glass-works at Zechlin, on the occasion of M. Fuss' researches.

It must not be imagined from this, as some persons have lately stated, that it is necessary to use gold in the state of Cassius purple.

Neri, at the end of the sixteenth and commencement of the seventeenth century, stated, that in order to stain glass a ruby color, it was only necessary to employ calcined chloride of gold. At a later period, Libar wrote to the same effect, and Merret certified that he had proved the efficacy of the process. In 1834 Golfier Besseyre stated, in the Journal of Pharmacy, that Douault Wieland colored his paste with perchloride of gold only. Lastly, in 1836, Fuss writes, that in Bohemia all the ruby-colored glass was prepared with chloride of gold

only, and that glass might be stained red as well with metallic gold, as with oxide of gold or Cassius purple.

It is therefore a fact known for some time, that glass may be stained red, without either Cassius purple or oxide of tin, with metallic gold or preparations of gold. In the glass-works of Bohemia and Silesia perchloride of gold only is used, without the addition of oxide of tin, in order to produce their fine rose or carmine-colored glass.

If powdered gold be triturated with twenty times its weight of enamel fritt, a light red or pink mass will be produced, without any metallic lustre. By heating for a length of time at a temperature of 110° of Wedgwood's pyrometer, a compound of metallic gold and quartz ground very fine upon porphyry, and intimately mixed, the latter will be stained a pink color. Pieces of gilt porcelain which have been a long time in use, are stained red at those parts where nearly the whole of the gold had become worn off; gold volatilizes under the action of a powerful electric battery, or the heat of the oxyhydrogen blow-pipe in the form of a very light purple powder. Fulminating gold, in detonating upon a silver plate also leaves thereon a purplish powder: if this latter is then mixed with silica and heated, it will be stained a reddish color; the gold exists in very minute particles, but not in the state of oxide.

If, by the aid of heat, a solution of gold in *aqua regia* be decomposed by means of oxalic acid, the liquor appears green and even blue, and a brownish powder is precipitated, the particles of which touching the sides of the receiver are yellow, and have metallic lustre. It is certain that this green, blue, brown, and sometimes yellow powder is metallic gold.

If perchloride of gold be treated with albumen and the precipitate exposed to the action of the solar rays, it will assume a red tint. A solution of gold colors the skin red. Silk dyed with perchloride of gold becomes blue, green, and purple, under the action of the solar rays. All these effects are certainly due to metallic gold.

It is evident that at the temperature of glass-houses, which is more than sufficiently high to effect the fusion of the glass, the gold contained in the Cassius purple will be brought back into the metallic state, whatever may be supposed to be the nature of this compound, upon which chemists have not yet agreed. If Cassius purple, chloride of gold, or gold leaf, be heated with borax or glass containing lead, to a temperature of 32° of Wedgwood's pyrometer, the gold will be precipitated in small globules at the bottom of the crucible, and if the heat be increased, the borax or glass will successively assume a yellow, brownish yellow, green, and bluish green, orange, deep orange, and lastly, a purple red color, according as the temperature is raised and kept up.

We have verified the following fact stated by Golfier Besseyre:—On triturating gold powder chemically pure with soot, mixing it intimately with a composition of glass containing lead (commonly called flint glass), and melting the whole in a glass-furnace, a glass is produced perfectly colorless at top, and presenting successively the following colors from top to bottom, viz:—greenish-yellow, topaz-yellow, yel-

lowish-brown, dark reddish-brown, and is even in some parts towards the bottom rather dull. M. Pohl has observed, that flint glass mixed with a small quantity of perchloride of gold, generally appears green after melting and cooling, some parts only having a red tint. On the contrary, on melting together glass containing a very small proportion of red lead and a small quantity of borax, with a solution in *aqua regia* of 6 ducats to 48 lbs. of fritt, after remaining in a state of fusion for six or seven hours, a perfectly colorless glass is obtained, which when worked into very thin plates, takes, upon cooling, a fine red color. Knox states that gold melted with glass stains it green, which is deeper in proportion to the quantity of silica it contains, and that if the temperature be raised, it changes to pale red.

It is well known that colorless glass containing no lead, but containing gold, remains colorless when cooled very slowly, but takes a red color when cooled suddenly, or when re-heated to a dull red heat. Splittgerber has lately proved that this takes place in a similar manner in atmospheric air, oxygen and hydrogen, surrounded by sand, by coal-dust, and protoxide of zinc, or in nitre and chlorate of potash melted: it cannot then be attributed to oxidation or reduction, but simply to a molecular change of the particles of gold, produced by the action of heat.

Golfier Besseyre observes, that on melting glass which has been stained red by gold, and keeping it in a state of fusion for some time, and cooling it very slowly, it becomes colorless, and on being again heated, again takes a red tint, bordering upon violet. By repeating this operation, the glass successively assumes violet and blue colors, and finally becomes completely colorless. Splittgerber confirms this fact by stating, that he had observed the density of colored glass to be somewhat less than that of colorless glass.

When glass stained by means of gold is heated too often, or exposed to too high a temperature, it takes a light brown color, loses its transparency, and will not again take a red color; on being looked through, it will be seen that some parts are colored a fine blue and bluish green, and grains of gold of various sizes may be seen with the naked eye (this state bears the greatest analogy to the phenomenon presented by a solution of gold slightly heated with oxalic acid.) Pieces of colorless glass containing gold, cooled very suddenly, cannot by any known means be made to take a red color, and remain perfectly colorless.

In conclusion we may state:—

1st. That in order to stain glass a red color by means of gold, it is not necessary to use Cassius purple, or to add to the chloride of gold either oxide of tin, or oxide of antimony.

2ndly. That by the addition of chloride of gold, or even metallic gold in minute particles, either to a very fusible glass of lead, or soda glass, containing a very small portion of minium (red oxide of lead,) glass may be produced which will take a red color whilst being worked.

3rdly. That if Cassius purple be employed, it will be decomposed during the fusion of the glass, and metallic gold will be precipitated from it.

4thly. That on grinding metallic gold to fine powder, upon porphery with hard substances, a red colored mixture will be produced.

5thly. That the coloring of the glass appears in all probability to arise from gold in a very comminuted state.

Several other metallic bodies present analogous phenomena.

Platinum and iridium in powder, mixed with enamel or fritt, prodnce a fine non-metallic black. Metallic silver colors glass a transparent yellow, seen by refraction, and an opaque grayish and bluish green, seen by reflection. If this glass be heated too often it becomes semi-opaque, and small grains of silver appear; this is precisely similar to the effect produced by gold.

In conclusion, it will be sufficient to cite the remarkable changes of color produced by a change in the molecular state of iodide of mercury, carbon, sulphur, solenium, phosphorus, mercury, oxide of iron, &c., to prove that there is nothing to prevent gold presenting the same phenomena.

Obtaining a Blue Color by oxide of Copper.—It is known that oxide of copper furnishes green or blue solutions; and will also stain glass a fine emerald green and light blue, turquoise blue, and sky blue.

For some years past a white milky glass has been manufactured in Bohemia and Silesia, known under the name of alabaster glass. The composition of this glass does not differ from that of ordinary crystal. (Bohemian crystal is a glass made without lead, with potash for its base.) After the glass has been melted, it is poured off and stirred up. A second charge is then melted, to which is added, when the fusion is complete, the glass previously stirred and cooled, which cools the mass; and as soon as it is melted, it is to be worked at the lowest possible temperature. The glass will be of a milky white, while if the temperature were much raised, it would become colorless and transparent.

If oxide or sulphate of copper be added to a colorless glass, and the temperature is sufficiently high, a transparent glass of a bluish green tint will be obtained. If the operation has been carried on as above stated to obtain a milky glass, it will be of a turquoise-blue color. Lastly, if this turquoise-blue colored glass be re-melted, at a high temperature, a transparent aqua-marine blue will be produced.—*Bulletin de la Société d' Encouragement.* Lon. Jour. of Arts and Sci.

Observations on a paper by Prof. Faraday concerning Electric Conduction and the Nature of Matter. By Richard Laming, Esq.

To Richard Taylor, Esq.

Sir.—In February of last year a letter from Professor Faraday was published by you, expressing an opinion that the immaterial centres of force of Boscovich* have a greater claim to be regarded as true than the solid atoms of Newton; and in which he represents his preference to result from the contemplation of certain *facts* relating to

[*See Priestley's "History of Vision," &c., and "Disquisitions on Matter and Spirit," vol. i. p. 34. &c.—Ed.]

electrical conduction and insulation. In going over his arguments I have not arrived at the same conclusion, owing to a difficulty in admitting an assumption which I find mixed up with the facts. It will be better to give Mr. Faraday's meaning in his own words, he says: "The view of the atomic constitution of matter which I think is most prevalent, is that which considers the atom as something material having a certain volume, upon which those powers were impressed at the creation, which have given it, from that time to the present, the capability of constituting, when many atoms are congregated together into groups, the different substances whose effects and properties we observe. These, though grouped and held together by their powers, do not touch each other, but have intervening space, otherwise pressure or cold could not make a body contract into a smaller bulk, nor heat or tension make it larger; in liquids these atoms or particles are free to move about one another, and in vapors or gases they are also present, but removed very much further apart, though still related to each other by their powers..... If the view of the constitution of matter already referred to be assumed to be correct, and I may be allowed to speak of the particles of matter and of the space between them as two different things, then space must be taken as the only continuous part, for the particles are considered as separated by space from each other." All this may be accepted as descriptive of matter as it is regarded by the theory of solidity; and with this admission we proceed at once to the main question, namely, to which of the two parts of a body does its electrical conducting property belong; does it appertain to the centres of force themselves, or to the spaces which envelope them? I agree with Mr. Faraday that the conducting property does not belong to space, because if it did, it would follow that as all bodies indiscriminately are replete with spaces, so all bodies, without exception, would be conductors, however much their natures might otherwise differ. This conclusion is manifestly inevitable, for to deny it would be to impute different qualities to different parts of space. Not so inevitable, however, is the next conclusion which I have to notice: "Metal is a conductor; but," says Mr. Faraday, "how can this be, except space be a conductor? for it is the only continuous part of the metal; space therefore (holding the theory of solid atoms) must be a conductor, or else the metals could not conduct." That gentleman therefore sees no alternative but in believing that "the reasoning ends in a subversion of the theory (of solid atoms) altogether."

This second conclusion would be as unavoidable as the preceding one, provided we knew, *as a fact*, that absolute continuity is necessary to electrical conduction; Mr. Faraday has assumed this to be the case, but I am not aware that anything has ever been observed in the nature of matter from which it can be inferred. By the old maxim, that *matter cannot act where it is not*, absolute continuity is made necessary to conduction; but this maxim is itself an assumption needing the evidence of facts, and therefore it may not be adduced as a proof of any other assumption.

The chief cause why I have thought it necessary thus to attempt

the vindication of the theory of atoms from a charge of inconsistency, is because I think there is a way of looking at that theory, by which the conducting and insulating properties of bodies appear more intelligible than on other doctrines; and this without involving any other assumption (beyond the mere existence of the atoms) than the hypothesis that ***different sorts of atoms are naturally associated with unequal quantities of electricity.*** The degree of probability attaching to this hypothesis may be estimated by reflecting that if we had to assume its untruthfulness, that is to say, that all atoms, however unlike in their natures, had equal quantities of electricity naturally combined with them, the assumption might be deemed much more questionable. I will now beg permission to give an outline of the view I have taken of the theory of atoms, so far as it relates to electrical conduction and insulation; and as it is simple, it may be done in a few words.

In his "Researches," Mr. Faraday has adduced an experiment to prove that the quantity of electricity naturally combined with matter is enormously great; after making every allowance for the difficulty of a correct estimation, we may safely infer the quantity to be great enough to apportion to each atom of matter sufficient electricity to envelope it. In the second place, we know, by facts, that the force by which electricity is attracted by matter is greater at shorter distances; from whence it follows that the electricity around an atom of matter will approach to it as near as possible, thus forming a sphere of which the atom is the centre. Again, by the theory of solidity, a mass of electrical matter, or electricity, may be regarded as composed of electrical atoms, just as a mass of ordinary matter contains ordinary atoms; and thus the sphere of electricity which surrounds an ordinary atom will consist of a number of electrical atoms arranged in concentric strata. The number of electrical atoms belonging to a given ordinary atom may be assumed to be such as to complete its external spherical stratum, or, on the contrary, it may be such as to leave that external spherical stratum more or less imperfect. Now, in the former of these two cases, where the sphere of electricity has an unbroken surface, we have all the conditions necessary for electrical insulation: and in the latter case, where the surface of the sphere of electricity is broken, we have all the conditions essential to electrical conduction.

To explain this more fully, we may begin with conductors. Imagine a line of ordinary atoms, each of which *naturally* has on the bounding surface of its mass of electricity, *ten* electrical atoms; and place the ends of this line in connexion with two bodies oppositely electrified. Thereupon so many of the electrical atoms of the plus charge as can find room will place themselves in the broken electrical stratum of the first ordinary atom of the conductor; because when there *a certain part* of each electrical atom then in that stratum, in the aggregate amounting to *ten* whole atoms, will be attracted by the said ordinary atom. This manifestly is required by the law of force, which is greater at the lesser distance; and because the aggregate of all the parts is at a less distance than are any *ten* whole atoms in the same stratum. At the other end of the conducting line, the negative

body will be appropriating to itself the *ten* superficial electrical atoms naturally belonging to the most proximate ordinary atom of the conductor; because this atom in its turn, can make an equal demand upon the next in succession, that one on its neighbor, and so onward continually to the plus end of the line, *without at any time the attractive force being called upon to act at an increased distance.* The first *ten* plus atoms being thus virtually discharged into the minus body, a second similar number will then be transferred in like manner, and after that a third, and thus the conducting action will be repeated as many times as is requisite to convey the whole electrical charge of the plus body into that which was equally minus. According to this explanation of electrical conduction, that phenomenon essentially depends on the facility possessed by an ordinary atom to receive on the surface of its mass of electricity a surplus of electrical atoms *at an equal distance from the common centre, as are already some of its own.*

In the case of insulators, we have ordinary atoms with perfect external spherical strata; a condition obviously incapable of conducting electricity, because no surplus number of electrical atoms, presented by a plus body, can possibly arrive so near to the first ordinary atom of a line as are already its own most distant electrical atoms.

It is not my intention, Sir, to enlarge here on this view of matter and of electrical action, because to trace the branches of the subject would exceed the limits that could be allowed in your valuable periodical. I hope soon to lay before the public my electrical opinions in a detailed form; but, before concluding my letter, I will just allude to what appears to me to be an aptitude in the theory of atoms to meet the exigences of electrical excitation and chemical affinity; which I think may both be shown to proceed from one and the same cause, the difference in result depending only upon unequal susceptibilities to locomotion. To have the most simple case, imagine two dissimilar ordinary atoms to be placed in contiguity; the atoms, being dissimilar, have unequal quantities of electricity around them, forming spheres of unequal radii. On the surface of each electrical sphere let there be one electrical atom, necessary to make up the complement of its mass of electricity. It is manifest that, on the reciprocal approach of the electrical spheres, the two external electrical atoms will place themselves between them, both in a line at right angles to the common axis, and in this position *one-half* of each external electrical atom be attracted towards each ordinary atom. If the ordinary atoms be now forcibly separated, *both* of the external electrical atoms will attach themselves to the sphere of least radius; because the electrical attraction acts with the greater force at the lesser distance, and because also an atom is by its nature indivisible.

Clichy-la-Garenne, near Paris, Oct. 4, 1845.

Lond., Edin. & Dublin Philos. Mag.

An Experimental Exposition of some of the recent applications of Electricity, particularly of the Electro-Magnetic Machine, to Silvering and Gilding. *By* **George Wilson**, M. D., F. R. S. E., F. R. S. S. A.

Dr. Wilson commenced by stating, that although different observers had noticed that the decomposing action of electric currents might be applied to the reduction of metals for practical purposes, the art of Electro-Metallurgy must be considered as dating from Daniell's invention of the Constant Voltaic Battery. He then mentioned, that in the year 1839, Messrs. Jordan and Spencer, in this country, and Jacobi, in Petersburg, contemporaneously announced their processes for making metallic casts of bodies by electricity. Soon after, Mr. Mason devised an improved battery for the purpose. Mr. Murray showed that non-metallic bodies might be made to receive coatings of metal, by covering them with black lead. Mr. Smee introduced a great improvement on the voltaic apparatus in use. Mr. Elkington discovered and applied a new class of gold and silver salts to electro-plating. Lastly, Mr. Woolrich, of Birmingham, substituted the magneto-electric machine for the voltaic battery which had been employed by all his predecessors. Dr. Wilson stated that he had brought Mr. Woolrich's method before the Society, because there was every reason to believe that it would supplant all the plans at present in use in electro-metallurgy.

The magneto-electric machine consists of a large compound horse shoe magnet laid horizontally, in front of which, a bar or keeper of soft iron, surrounded by coils of covered copper wire, is made to rotate.—The electricity is obtained from these wires, in virtue of the following law :—If a copper wire be approached to a magnet, a momentary wave or current flows in one direction along the wire. If the wire be withdrawn from the magnet, a second wave or brief current passes along it, but in the opposite direction from that which showed itself when it was approximated to the magnet. In this way a series of alternating electric currents, in opposite directions, may be obtained. On this principle the magneto-electrical machine is constructed. The soft iron keeper which revolves in front of the horse shoe magnet becomesa temporary magnet whenever its rotations bring it in front of, and in the same plane with the permanent one, and ceases to be one when it has turned so as to be at right angles to the horse shoe. Every time the keeper becomes a magnet an electric current flows along it in one direction, and on each occasion of its ceasing to be one, a second current shows itself in the opposite direction. These currents flow along the wires surrounding the keeper. In the course of the revolutions of the latter, moreover, each extremity comes to be alternately opposite the north and the south poles of the permanent magnet. This also occasions a reversal of the direction of the electric currents. In consequence of these alterations, the magneto-electric machine without some further equipment is useless for the purposes of the electro-metallurgist, as the counter currents necessarily destroy

each other, and no permanent chemical decomposition can be effected by them. Mr. Woolrich obviated this difficulty, by attaching to the magneto-electric machine a very simple and ingenious break, or contrivance, by which a uniform current is obtained. This cannot be explained without a diagram. A drawing of it will be found in Shaw's Electro-Metallurgy. Its effect is to provide a new circuit for each current, at the moment that its direction changes, so as to carry all the positive electricity by one channel and the negative by another.

Dr. Wilson "*exhibited a Magneto-Electric Machine*," fitted up with Mr. Woolrich's break, and showed, by the uniform direction in which it moved the needle of a galvanometer, that the originally alternating currents were converted into a continuous one. Its application to Electro-Metallurgy was further illustrated by employing the current from it, to plate with silver a copper medal.

It was also mentioned that Mr. Woolrich had successfully substituted for the expensive Cyanide of Potassium, previously in use, a much cheaper salt, the sulphate of potass, as solvents of the silver and gold employed in Electro-plating. Dr. Wilson concluded by stating that the superiority of the Magneto-Electric machine, over the Voltaic battery, as a source of Electricity, was great. The expense of maintaining the keeper in rotation was the only outlay needed to secure the efficacy of the instrument. So that, though originally more expensive than the Voltaic Battery, it was, in the end, much less costly. It is also much more cleanly, and quite under control. By increasing or diminishing the magnetism of the keeper, which can be effected by altering the distance at which the horse shoe magnet stands from it, and by other methods, as well as by varying the speed at which the keeper revolves, the quantity and intensity of the Electricity can be varied within wide limits, accurately adjusted to suit the exigencies of the Electro-Metallurgist.—*Proceedings Royal Scottish Society of Arts.*

Civ. Eng. & Arch. Jour.

New Apparatus for Extracting the Coloring Matter from Dye Woods.

Communicated to the Society of Industry by M. Iwan Schlumberger.

At a meeting of your committee of chemistry, I communicated the advantages which I had found in the apparatus of Mr. Meissonnier for extracting the coloring matter of logwood. Some members appearing to doubt the real merit of this apparatus, or not having produced results analogous to mine, on trying it, I made some fresh experiments, which I explained to your committee of chemistry, accompanied by calculations which any other persons might make.

It is of some of these experiments I am now about to speak.

In order to make decoctions of logwood, the usual method is to put a quantity of shavings of that wood into a boiler in immediate contact with the fire, together with a quantity of water, sufficient to cover the wood completely, so that after boiling for some hours the wood may be quite covered. The operation is renewed twice with the same

liquor, and after three successive boilings, the decoctions are mixed together and evaporated to the degree required.

This operation is attended with several disadvantages. Shavings only can be employed, for if the logwood is reduced to powder, it absorbs so much water that a great quantity of liquid is lost, and the shavings being rather thick, the water cannot readily penetrate, for which reason the time of boiling is very much prolonged.

Notwithstanding these three long boilings, if the same wood be boiled a fourth time, a liquid pretty well colored is obtained; which clearly shows that all the coloring matter has not been extracted.

Besides this, when decoctions of logwood are required in large quantities, very large vessels and extensive premises are necessary, as well as several furnaces, in order to produce a sufficient quantity; for the wood, when in shavings, is very bulky without being heavy, and large boilers are required for making a decoction from 50 lbs. of shavings, with the necessary quantity of water. Several boilers must therefore be employed, otherwise the fire must be kept up day and night.

I will here describe, *en passant*, for the benefit of those persons who have not many furnaces, but who have a steam-pipe at command, a method which I have employed for some time to make decoctions in great quantities, and which I think I can recommend in this instance.

A large high narrow vat, capable of containing about from 100 to 150 lbs. of wood shavings, is mounted upon a stand or framing, and furnished with a cock below, in order to draw off the liquor. At a short distance above the cock, inside the vat, a false bottom or diaphragm, pierced with holes very close to each other, is fixed, in order to leave a space at the bottom to prevent the wood from clogging up the cock, and stopping the flow of the liquor. A steam-pipe, about one-third of an inch in diameter, is carried to the bottom of the vat, which is filled with shavings. It is covered with a cloth and a cover, which is weighted, in order to prevent the steam from issuing out in too great abundance. The shavings must not be heaped up more than in the common boilers. In this state, steam is allowed to flow in for an hour at least, until it escapes out in moderate quantities at the top. During this time the wood swells and becomes penetrated by the steam; then when the vat is filled with water, it will be sufficient to heat to the boiling point, in order to obtain, the first time, a strong decoction. The vat is afterwards filled twice in succession, and made to boil as usual; and in the same space of time, with less labor, a much larger quantity of decoction is obtained, and much more coloring matter extracted.

By the two methods just mentioned, considerable time is required for each operation, and the wood is not entirely exhausted of coloring matter; but with M. Meissonnier's apparatus much more advantageous results are attained.

This improved apparatus consists of a copper boiler of about a foot and a half in width, and about two feet in depth. At a short distance from the bottom of the boiler is a false bottom, pierced with a multi-

tude of holes, which sustains the wood in the water, and leaves an empty space for the boiling liquor. Into the boiler powdered wood is thrown, and it is covered first with strong wire-work, and then with a copper plate, pierced with small holes, which cover is held firmly down upon the edges of the boiler by any suitable means. At the side of the boiler is a small lift and force-pump, simply constructed, which draws the boiling water from any suitable vessel, and forces it through a pipe into the empty space at the bottom of the boiler. The water after passing through the wood and the pierced cover of the boiler, is run off into any suitable receiver.

In our manufactory, at the side of the pump is a boiler, heated with a coal-fire, capable of containing 450 quarts of water which is to be boiled for each operation. After filling it, and lighting the fire, the other boiler is filled with powdered logwood, spread as evenly as possible, until it contains from 84 to 90 pounds of wood. The water having arrived at the boiling point is then forced into the space at the bottom of the vessel containing the dyewood, and driven up through the wood. In this manner, in two hours, the 450 quarts pass through and extract all the coloring matter from the dyewood.

The liquor which has passed through the wood is divided into three distinct portions,—in this manner: a first portion of the decoction may be 3½° Beaumé; a second, 1½°; a third, ½°; and lastly, a fourth portion of liquid very slightly colored, which may be mixed with the water for the next operation. In this manner the most advantageous results are secured, as three decoctions of different degrees of strength are obtained at one working, without evaporation.

When a second operation is not commenced immediately, the waste heat of the furnace is employed to concentrate the liquor.

I will compare the advantages of this apparatus with that which we were obliged previously to use.

Thus, in a boiler heated by fire, 140 pounds of shavings and 80 quarts of water were put, and the liquor was boiled for four hours: this was renewed three times. For 40 pounds of logwood, it was, therefore, necessary to boil 240 quarts of water for 12 hours. I double these quantities the better to compare them with those produced by the new apparatus. Thus, by the old method, for 80 pounds of wood it was necessary to boil 480 quarts of water during twenty-four hours.

By the novel method, when from 84 to 90 pounds of wood are operated upon, two hours are necessary for heating the 450 quarts of water, and two hours for pumping it through the wood. Therefore, for 84 pounds of wood, it will be necessary to heat 450 quarts of water for four hours, effecting an economy of fuel for twenty hours' consumption.

Besides this, the coloring matter is better extracted, and a great economy of labor is effected, as one man can effect two operations per diem.

Several precautions are necessary, in fact indispensable, to ensure complete success; for instance, the wood must be very evenly spread, in order that the resistance offered to the water may be equal through-

out: and, for this purpose, the wood must be put into the vessel in small quantities at a time. A very important point is, to have the wood ground or rasped of a uniform size, without fine dust, as the particles of this latter are apt to adhere together, and offer great resistance to the water at certain parts; thus preventing the coloring matter from being extracted therefrom. I have found that the wood spreads much better by previously wetting it.

For some other woods, such as Lima and Pernambuco woods, and other red dyewoods, 600 quarts of water, instead of 450, must be employed, as the coloring matter is not so easily extracted. Quercitron cannot be operated upon, as it is in too fine a powder. Cochineal does not succeed, as it swells so much on coming in contact with boiling water that, in an experiment I made, I thought it would have burst the boiler.

This apparatus is, however, very advantageous for the woods abovementioned, if the directions given are carefully followed.—(*Bulletin de la Société Industrielle de Mulhouse.*) Lon. Jour. of Arts & Sci.

Experiments on the Strength of Cast-Iron Girders.

In a paper read by Mr. Redman at the Institution of Civil Engineers, an account was given of some experiments on the strength of the girders which support the platform of the Terrace Pier, Gravesend. We cannot avail ourselves of the whole of Mr. Redman's paper, as the subject has been already noticed in this Journal. The following particulars will however be acceptable.

The columns of the pier are held together at their tops by means of cast-iron cross-bracing frames, fitted between the caps and bolted to them (fig. 1;) they were provided with a projecting clip at each angle, to support them while fitting, before the bolts were placed in.

A, B, represents one of these braces at right angles to the length of the platform. The columns supporting the platform are arranged three by three, consequently the brace is attached in three places—its centre and two ends. The figure also shows truncated portions of the longitudinal girders (A, B, C,) and some of the cross joists of the platform.

The three girders which support the platform over the esplanade, from the abutments to the first tier of columns, and those of the T head of the pier are cast to one section (fig. 2;) the nine girders forming the three main openings are also of one section (fig. 3;) six of them are 54 ft. 9 in. long, and the three next the T head are 55 ft. 9 in. long; they are all of a parallel depth and breadth top and bottom, and the long girders are cambered 1¼ inch in their length; they are all provided with projections on the top flanch to receive the joists. The weight of these girders is very materially reduced, by making the sectional area of the ends about one-half of that at the centre, (figs. 2 and 3.) The smaller girders were proved to 20 tons on the centre, with which they deflected, on an average, $\frac{7}{32}$ inch, and the large girders were proved to 45 tons on the middle. Their deflection averaged $1\frac{3}{32}$ inch, and the results, as shown by the table of experiments, were

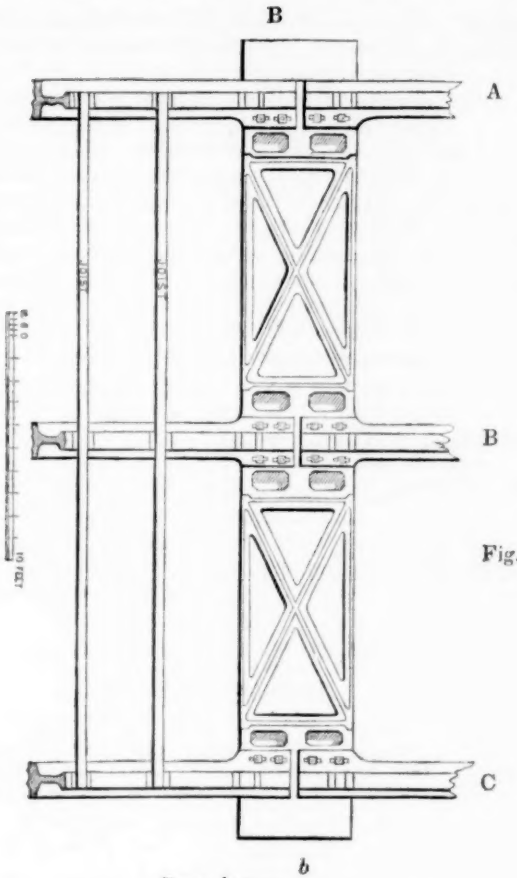
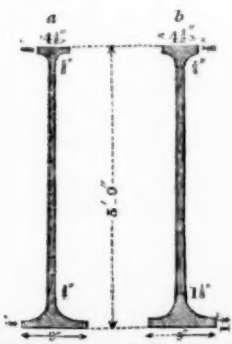


Fig. 1.

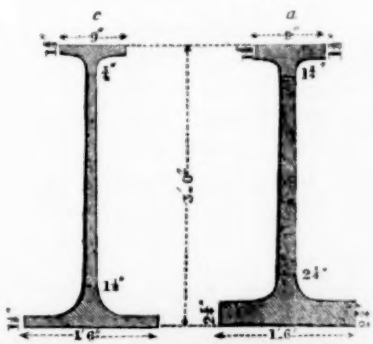
Cross braces.

Fig. 2



Section of the abutment girders.

Fig. 3.



Section of long girders.

very regular. The section at the end of the abutment girders is marked *a*, the section at the centre *b; c* is the section at the end of one of the top girders, and *d* the section at its centre.

The girders are secured from lateral twist and vibration by wrought-iron ties, 2 inches diameter, with clip ends, embracing the top flanches of the outer girders, and keyed to them; they are screwed up to a casting fitted and keyed upon the centre girder. These ties are fixed over the centres of the main spans; the abutment girders and those of the T head on the N. E., S. E., N. W. and S. W. sides (which are most exposed) are secured in a similar manner, the ties being, however shorter, and secured to the joists which form the tie.

Table of Experimental Tests of the Strength of the Cast-Iron Girders, showing the deflections at their centres in inches.

ABUTMENT AND T-HEAD GIRDERS.

Weight in Tons.	No. 2, Abutm'nt Girders.	No. 1, Abutment and No. 1 T head Cantilever.	T head E. and W Girders.	T-head S E. & S.W. Girders.	No. 2, T-head Canti-lever.	No. 2, T-head Canti-lever.	Average of all.
5	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{3}{32}$	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{16}$
10	$\frac{3}{32}$	$\frac{3}{32}$	$\frac{1}{8}$ $\frac{1}{32}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$ $\frac{1}{32}$	$\frac{1}{8}$
15	$\frac{1}{8}$ $\frac{1}{32}$	$\frac{3}{16}$	$\frac{3}{16}$ $\frac{1}{32}$	$\frac{1}{8}$ $\frac{1}{32}$	$\frac{3}{16}$	$\frac{3}{16}$ $\frac{1}{32}$	$\frac{3}{16}$
20	$\frac{3}{16}$ $\frac{1}{32}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{16}$ $\frac{1}{32}$
Bearing.	22 feet.	22 feet.	25 feet.	21 feet.	21 feet.	21 feet.	22 feet.

LONG GIRDERS.

Weight in Tons.	No. 2 Girders 54' 9'' long.	No. 2 54' 9''	No. 2 55' 9''	No. 2 54' 9''	No. 2 54' 9'' and 55' 9''	Average of all.
5	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{3}{32}$	$\frac{3}{32}$	$\frac{1}{16}$
10	$\frac{3}{16}$	$\frac{3}{16}$ $\frac{1}{32}$	$\frac{3}{16}$	$\frac{3}{16}$ $\frac{1}{32}$	$\frac{1}{4}$ $\frac{1}{2}$	$\frac{3}{16}$ $\frac{1}{32}$
15	$\frac{5}{16}$	$\frac{5}{16}$ $\frac{1}{32}$	$\frac{5}{8}$ $\frac{1}{32}$	$\frac{5}{8}$ $\frac{1}{32}$	$\frac{5}{8}$ $\frac{1}{16}$	$\frac{5}{8}$
20	$\frac{7}{16}$ $\frac{1}{32}$	$\frac{1}{2}$ $\frac{1}{32}$	$\frac{1}{2}$ $\frac{1}{32}$	$\frac{1}{2}$ $\frac{1}{16}$	$\frac{5}{8}$	$\frac{1}{2}$ $\frac{1}{32}$
25	$\frac{5}{8}$ $\frac{1}{32}$	$\frac{5}{8}$ $\frac{1}{16}$	$\frac{5}{8}$ $\frac{3}{32}$	$\frac{3}{4}$	$\frac{3}{4}$ $\frac{3}{32}$	$\frac{5}{8}$ $\frac{1}{16}$
30	$\frac{1}{4}$ $\frac{1}{32}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$ $\frac{3}{32}$	$\frac{7}{8}$
35	$1\frac{1}{16}$	$1\frac{3}{32}$	$1\frac{3}{32}$	$1\frac{1}{16}$	$1\frac{1}{8}$	$1\frac{1}{16}$
40	$1\frac{1}{4}$	$1\frac{1}{4}$ $\frac{1}{32}$	$1\frac{1}{4}$ $\frac{3}{32}$	$1\frac{1}{4}$ $\frac{1}{32}$	$1\frac{5}{16}$	$1\frac{1}{4}$ $\frac{1}{32}$
45	$1\frac{3}{8}$	$1\frac{3}{8}$ $\frac{1}{16}$	$1\frac{3}{8}$ $\frac{1}{16}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{3}{8}$ $\frac{1}{32}$
50	..	$1\frac{5}{8}$ $\frac{1}{32}$	..	..	..	..
Bearing.	50 feet.	46 feet.	50 feet.	50 feet.	50 feet.	49·2 ft.

To test the quality of the iron, bars 1 inch square and 3 feet 3 inches long, were cast horizontally from the ladles from which the castings were run, and were broken across with a bearing of 3 feet. The average breaking weight, of sixteen experiments, was 782 lb.; the highest result was 896 lb., and the lowest 672 lb.; in this latter case the bar was barely of the prescribed size, and two small air-holes appeared in the fracture. The other cases that yielded the least amount of resistance were also, generally, barely of the proper dimensions, or there

were air vacuities. In most cases, where air-bubbles occurred, the bars did not break at the centre, but they discovered the faulty place nearest to the centre, in some cases as much as 2 inches from it.

After reading the paper referred to, Mr. Redman added, that with respect to the form and the dimensions of the cast-iron girders, he would not in future, for several reasons, reduce the thickness to such an extent towards the extremities. The parallel form had been adopted on account of the greater facility afforded for attaching the entablature and the platform, but the beams (which were of great length) twisted much in cooling, in consequence of the inequality of thickness of the metal, and this gave some trouble in fixing them. The girders had returned to their original camber after the removal of the strain applied in testing them. He had not observed that there was any perceptible deflection from their own weight, before the strain was applied.

Mr. J. R. McClean said, in allusion to the length of the cast-iron girders, the longest beams that had been executed in Staffordshire were those for the bridge on the Tame Valley Canal; they were designed by Messrs. Walker and Burges, and were cast at the Horseley Iron Works.

The dimensions of the girders of the bridge at Perry Bar, and of the Towing Path Bridge at the junction of the Birmingham and Fazeley Canal were—

	Perry Bar. Ft.	In.	Towing Path. Ft.	In.
Extreme length,	60	0	80	8
Between the bearings,	55	0	75	0
Depth at centre,	2	3½	1	8
Width of bottom flanch,	1	0	1	0
Thickness ditto,	0	3½	0	2¾
Ditto of body of girder,	0	1½	0	2
Width of top flanch,	0	6	3	7½
Thickness of ditto,	0	2½	0	1¾

Mr. Redman has subsequently communicated to the Secretary of the Institution of Civil Engineers a letter from Mr. Fairbairn, in which he says:—

"Since the receipt of your note of the 13th instant, I have gone into the calculations of the strengths of the girders composing the Gravesend Terrace Pier, and find them as under:—

Breaking weight of the large bearers, 50 feet span,	81½ tons.
Breaking weight of the small bearers, 22 feet span,	35 "

"I have computed these weights on the assumption that I am correct in the distances between the supports, and that the other parts of the section are a proportional of the middle, which I find to be nearly the case. You may therefore consider the whole perfectly secure if not loaded beyond 80 tons in the one case, and 30 tons in the other, equally distributed over the surface or whole length of the bearers."

Civ. Eng. & Arch. Jour.

On the Use of Madder in Dying and Printing Calicoes, &c. By M. Sass.

Translated from La Société d' Encouragement, for the London Journal of Arts.

The object of this branch of our manufactures is to unite the coloring matter of the madder with the mordants previously fixed in the fabric. Our almost entire ignorance of the manner in which this combination is effected is the most serious obstacle to be met with by the manufacturer, as it deprives him of any certainty of attaining the desired object; in fact, the art of printing calicoes has hitherto been, and still is, almost entirely founded upon experience.

The fundamental conditions necessary for the proper carrying out of this operation, that is to say, the union of the mordant with the fabric, and of the coloring matter with the mordant, having been properly effected, *i. e.*, the fabric having been dyed, any accidents which may afterwards happen may be easily foreseen, and, consequently, may be generally avoided. Among these are the defects caused in brightening or bringing out pinks and violets; these are only produced when, on employing too strong a mordant, or too small a quantity of solution of tin or sulphuric acid, the bath has to be heated to a higher temperature than 30° Reaumur. The violet spots which appear upon pinks, especially in designs with a ground, arise from the contact of ferruginous matters, which is dangerous, especially if the fabrics undergo the brightening process before they are submitted to the action of the soap; the color is then so sensitive that I have seen it instantly change to violet under the influence of a perfectly limpid drop, but which fell from a bar of iron upon which it had condensed. An iron nail fixed in the oaken planks of a brightening vat, although sunk one-third of an inch below the surface, stained all the fabrics brightened in the next compartment. The white stains which appear upon violets after undergoing the brightening process, appear whenever pieces badly washed are treated with hypochloride of soda, or if this latter is sprinkled over them before being washed; this is obviated by well washing the fabrics after undergoing the brightening process, and by placing the vat containing the hypochloride at a distance from the brightening vat.

These few examples will suffice to prove that all the variations which occur in printing calicoes arise from the fact of our not knowing how the combination of the coloring matter, the mordant, and the fabric is effected. When this has been discovered, the causes which influence it will also be found out, and only then will there be any certainty of always obtaining products of fine quality.

Combination of the Mordants with the Fabric.—The causes which determine this are either physical or chemical. Among the first, the impression presents defects arising from the fabric, the engraving, the color, and the pressure exercised whilst printing. The more regular and fine the texture of the fabric, the more perfect will be the impression; if, however, the texture is too close, the mordant, being unable to penetrate, remains on the surface of the fabric, in

scales, which partially peel off, and only gives, upon dyeing, dull and unequal colors.

With regard to the engraving and pressure, what we are about to state concerning cylinders applies equally to block-printing. If the engraving on the cylinder is not of equal depth throughout, unequal shades are produced. The cause of this defect has been turned to advantage, in order to obtain two different shades with a single cylinder and color; it is sufficient, for example, in order to produce, with the same cylinder, red and pink, to engrave those parts which are to produce the latter tint less deep than those which are to produce the red. As this kind of design, which is very difficult to engrave, furnishes for the lighter shades very little color, it is almost impossible to obtain them uniform and without spots or inequalities, which is more perceptible after the brightening process; it is therefore chiefly employed for deep blues, &c. The manner of engraving also greatly influences the intensity of the colors. Bitten and outlines always produce deeper shades than what is technically called chalk engraving, as the latter takes up much less color than the others.

The speed at which the cylinder is driven must also be taken into consideration, as the faster it revolves the lighter will be the shades, because it deposits less color upon the fabric. If the pressure upon the roller is too great, although the texture of the fabric may be suitable, the color passing through the fabric is not fixed there, and produces, on dyeing, very bad and unequal shades; if, on the other hand, the pressure be too light, the same defect is produced, but from a different cause, as in the latter case, the color merely touches the fabric, and does not penetrate, but remains on the surface, and ultimately falls off. This method of printing is subject, besides, to another very serious inconvenience, that of producing unequal shades, arising from the action of the pressure cylinder upon the engraved cylinder never being perfectly uniform; and this defect, which may be avoided by great pressure, appears on the contrary in all its force when the pressure is too light.

It will hence be perceived, of what importance it is that the pressure from the handle upon each extremity of the pressure cylinder should be as uniform as possible, in order to obtain a uniformity of shade. This defect in printing may be easily ascertained; it is only necessary to examine both edges or selvages of the fabric, which ought to be precisely similar; if one is of a deeper shade than the other, the pressure is not uniform.

The defects arising from the color depend upon its thickness and the nature of the mordant. If the color is too thick, it does not enter into the lines of the engraving; if too thin, it runs and spoils the design: a medium between these must be found, which long experience alone can teach, and which varies not only with each kind of fabric (the color being thinner in proportion as the texture is fine), but also with each kind of design; for the more the design is charged, the thinner the color must be; for this reason, designs printed on a colored ground, can only be well done with gum colors, as those with starch cannot, without being decomposed, be diluted beyond a certain limit,

which is not adapted to obtain the desired object. Colors thickened with gum have the defect of producing, during printing, a great deal of froth, which, if not removed as fast as it forms, becomes fixed upon the fabric, and only produces feeble colors, as it contains but little mordant. Starch colors froth up very little, and this may be easily prevented by adding a little sulphate of lead, which appears to act in dividing the mass. The thickeners also exercise respectively a peculiar action upon the mordants; thus, a color which, thickened with starch or flour, is very deep, is much less so when thickened with gum or burnt starch; this latter substance, in dyeing, gives much less brilliant shades than starch or gum. Gum tragacanth, dextrine, salep, and sugar, act precisely in the same manner as gum, and produce brilliant colors.

The physical causes of the defects occasioned by the drying of the pieces after printing, arise from excess or deficiency of heat, and the stagnation of the air. The drying must take place as rapidly as possible, in order to prevent the colors from spreading upon the fabric, and spoiling the design; and, for this purpose, the drying-stoves are ordinarily heated to 30° Reaumur, in order to dry the pieces directly. Care must, however, be taken not to exceed that temperature, which is known by practice to be the best for mordants, especially for the aluminous ones; as, by that means, the colors might become incrusted, and fall from the fabric, which is especially the case with those prepared with gum. A less degree of heat is maintained when the cylinders are charged with very strong iron mordants, or steam colors, and especially ground colors, which are the more brilliant the more slowly they are dried.

The air must be renewed as often as possible in the stoves, in order to carry off the vapors of water and acid which are disengaged from the printed pieces; as the former might spoil the design by damping it, and the latter by transforming the mordant into an acetate, which would not combine with the fabric, and would therefore produce white spots. The same observations apply to the stretching room, in which the pieces are hung several days after printing, before dunging, in order to combine the mordant with the fabric; the temperature must not exceed 10° or 15° Reaumur, and the air must be sufficiently damp, that, in cooling, the pieces may be creased or folded without any rustling; they must not, however, be too damp, as the mordant would run. A certain degree of humidity, which may be known by experience, and which can be ascertained by a nygrometer, is indispensable to the union of the mordants with the fabric, especially when they have a base of iron, tin, iron and alumina, or tin and alumina.

The action of the air upon the fabrics, while hanging to dry, is chemical, although produced by physical causes: in effect, the damp air penetrates the stratum of color, and softens it, and carries off the acetic acid of the mordant, leaving the alumina with which it was chemically combined, but not yet in combination with the fabric, as it only combines therewith by a suitable degumming operation, without which only dull and feeble colors are produced.

At the degumming operation the purely physical causes which influence the combination of the mordant with the fabric cease; they are so closely allied to the chemical causes, that it is only by a long and persevering study of their action that the point where the former end, and the latter begin, can be ascertained. It appears that the degumming operation acts in a different manner, according to whether the pieces are submitted thereto immediately after printing, or after hanging to dry for forty-eight or sixty hours.

The action is chemical and mechanical; chemical in the first instance, because, if chalk or some other carbonate be not added to the dung-bath in sufficient quantity to saturate all the acid of the mordant, the latter will detach itself from the fabric, and become dissolved in the bath,—mechanical, because it facilitates the combination of alumina, either pure or in the state of a sub-sulphate, with the surface of the threads of the fabric. This assertion is confirmed by the fact, that the centre of all dyed threads remains perfectly white, the color-matter never going beyond the surface.

In the second case, all the acetic acid being separated from the mordant, the dung only is employed; the action of which is probably merely mechanical.

The mechanical action of the dunging is not confined to the union of the alumina with the fabric, by rendering it insoluble; but it also carries off a portion of the mordant not combined with the fabric; and likewise dissolves the thickening matter, which contains a considerable quantity of it. For this reason the degumming operation may be performed with equal advantage either with bran, dung, the dunging salt of Messrs. Kestner, or even by running water alone: this latter, which acts very slowly, especially in winter, is used chiefly for light colors, prepared with gum or torrefied starch; it possesses, besides, the disadvantage of allowing the mordant, which flies off from the impression, to fall upon the white parts of the piece and stain them, if the least fold or crease should be formed.

If there were no other action in the operation of degumming than that just pointed out, one would be led to imagine that the pieces would be perfectly dyed in the madder-bath, without degumming, as the madder possesses the same properties as the dung, which are all that are requisite for carrying off the thickening matter and the excess of mordant, and for allowing that portion which remains upon the fabric to become permanently fixed; but it is not so; the madder-dyed pieces never give good results, unless previously degummed; feeble colors, and imperfect and stained designs, are produced. This circumstance, contrary in appearance to the theory which I have deduced from facts, is easily explained, on comparing the action of the dung-bath with that of the madder-bath. As the pieces are put into the dye-bath whilst it is in a cold state, and before the mucilage has become dissolved, the thickened colors, being diluted without being dissolved, are detached by the movement communicated to the pieces, and carry off nearly all the mordant they contained; whilst, by the dunging operation, nearly all the mordant is fixed in the fabric, when the bath is sufficiently hot to carry off rapidly the thickening matter

dissolved therein ; and, moreover, all the excess of mordant which, in the dunging operation, is rendered insoluble, and carried off by the animal and vegetable mucilage, not meeting with that of the madder in solution, which would also take it up, falls back upon the fabric, combines therewith, and stains it. The six following experiments confirm this theory :—

A piece of ordinary calico, which had been printed about a week with a mordant alumina thickened with starch, was divided into six equal parts, of about 8 inches long by 4 wide, and treated as follows :—

No. 1,—Degummed, at a temperature of 12° Reaumur, in a dung-bath, prepared 12 hours previous with 500 grammes of dung to 4 quarts of water.

No. 2,—Degummed also in a similar bath, but heated to 50° Reaumur.

No. 3,—Was placed without degumming, at a temperature of 12° Reaumur, in a madder-bath, composed of 32 grammes of madder, of the best quality, to 4 quarts of water.

No. 4,—Was placed, without degumming, in a madder-bath, similar to No. 3, which had been prepared, in a cold state, 12 hours previously.

No. 5,—Was placed, without degumming, at 30° Reaumur, in a bath composed of 64 grammes of madder and 125 grammes of dung to 4 quarts of water.

No. 6,—Was degummed in water only, at 12° Reaumur, and dyed like No. 3.

Nos. 1, 2, and 6, after being degummed, were beaten, washed, and then dyed separately, in a similar manner to No. 3. With the six pieces, the dye-bath was raised in three quarters of an hour to 80° Reaumur, at which temperature it remained during 15 minutes; they were afterwards soaped, then brightened, and soaped a second time.

Results.—Nos. 1, and 2, were equal in beauty ; in No. 3, the impression was imperfect, and the ground stained ; in No. 4, the tint was as uniform as No. 1, but with only half the depth of color ; this arose no doubt from the mordant flying off, and combining with the madder, thereby rendering a portion of its coloring matter insoluble.

No. 5, tint so feeble as to be scarcely perceptible, caused by the absorption of the coloring matter of the madder by the ligneous part of the dung. No. 6, as fine as No. 1.

Let us now examine the processes of degumming most frequently employed. The operation of dunging is ordinarily effected between 30° and 65° Reaumur, in a wooden vat, 6 feet long, and 5½ feet in width and depth, well filled with water : in which, for 40 pieces of 50 yards long and ¾ wide, about 60 quarts of dung are dissolved, which is at the rate of three pints each piece; they are passed through it for a quarter of an hour, and on being taken out are rinced and beaten; they are then ready to be dyed, or to be again passed through the dung, in order to ensure a successful operation. There is no disadvantage in employing more than 60 quarts of dung for 40 pieces ; but a less quantity must not be employed, as, in that case, the mor-

dant, which leaves the fabric, not finding the mucilage necessary to precipitate it, is deposited upon the pieces which are passed through, and stains them.

The temperature at which the degumming may be performed is not very important, provided it be not lower than 30° Reaumur; for, in that case, its action would be very slow, there being no action from 0° up to 10°, as the mordant runs upon the fabric before the thickening matter is softened. When chalk or pipe-clay is added, it must be in the proportion of 500 grammes for each piece.

The time for the pieces to remain in the degumming-vat is, in general, a quarter of an hour; it must be prolonged in proportion to the coolness of the bath.

In roller-vats the pieces only remain two minutes, the action of the bath being so uniform upon the whole piece that the effect is, so to speak, instantaneous.

The same observations apply to degumming with bran and with the dunging salt; which process is effected upon forty pieces, with 15 kilog. of bran, or with 250 grammes of salt; care being taken to boil the first, in order to spread its mucilage throughout the bath, and to dissolve the second. With regard to the degumming by cold water, which is the most simple,—it consists in plunging the pieces in running water, keeping them well spread out, and leaving them there until all the thickening matter is removed; they are then carefully washed and beaten before dyeing: but this is neither an economical nor a certain process; for the least crease in the fabric forms a stain, because the excess of mordant not being carried off by the water, becomes deposited upon the fabric, and remains attached thereto.

Degumming by the use of chalk or pipe-clay only, is chiefly employed with iron mordants; it is liable to cloud aluminous mordants, probably because it combines with them in small quantities; that which would induce the belief of this is, that pinks degummed by the use of chalk only, have always a veiny tint, which is far from agreeable.

The greater the quantity of mordant employed, the less intimate is its combination, and, in consequence, the more easily detached, which is frequently proved in carrying on the process of dunging too rapidly; in that case, designs with two shades of the same color, one over the other, lose the more intense, which then becomes dull and lighter than the other; it is to avoid this defect that pieces printed with several colors are degummed twice, and even three times, in succession.

On coming from the dunging-vat, the pieces are washed several times in running water, beaten for a quarter of an hour, and washed again, in order to remove any particles of mordant or dung which might adhere thereto; they may then be dyed.

Experience has shown, that the degumming by dung gives the best results; and this substance being very susceptible of change, according to the kind of food taken by the cows, it may be concluded that its action is not always the same. In fact, we are of opinion that a variety of accidents in dyeing, attributed to the maddering, are owing simply to the use of dung, formed from matters which have changed

its nature; and as long as this substance is employed for such a purpose, the process will always be liable to very injurious variations. It is therefore necessary to remedy this evil, of which the extent may now be appreciated. Messrs. Kestner, in giving us their phosphates, have furnished us with the means, and we think that in this respect they have made an important improvement in the art of printing calicoes, &c.:—by using their salt we have always obtained favorable results.

Having now reviewed the means of combining the mordant with the fabric, we will proceed to the process of combining it with the coloring matter.

[To be continued.]

The Influence of Magnetism on Molecular Arrangements. By Robert Hunt, *Keeper of Mining Records, Museum of Œconomic Geology.*

To Richard Phillips, Esq., F. R. S.

Dear Sir,—Having been engaged some time since in investigating the influences of bodies on each other in the dark, the results of which investigations were published under the title of "Thermography," I then observed many peculiar effects which led me to believe that magnetic electricity had some influence in determining the arrangements of molecules. From that time until a few days since, the subject has rested with me without any further research. Having however put the subject to the test of experimental examination, I am induced, the results being of great interest, to transmit to you an account of my experiments. In doing this, I shall, for the present, confine myself strictly to a description of the arrangements used and the results obtained, reserving any theoretical views for some future period, when by a greater number and variety of experiments it appears probable some general law of action may be satisfactorily deduced.

1. I placed a concentrated solution of nitrate of silver in a test-tube, against the poles of a permanent horse-shoe magnet, having another tube containing a similar solution not in contact with it. The crystalization commenced first in the tube connected with the magnet, immediately at the point opposite the upper surface of the metal, fig. 1; a large tabular crystal shot off from this point towards the bottom of the glass, dividing the lower portion of the fluid in two parts. Other crystals sprung off from different points above and below this crystaline plate, but all of them arranged themselves at angles inclining towards the magnet; no crystalization taking place in the upper stratum of the fluid. In the other tube, crystals formed irregularly throughout the fluid, but in no part were the crystals so dense as in the tube which I suppose to be under the influence of magnetism.

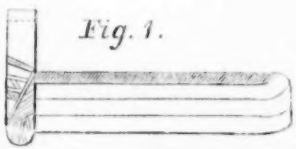
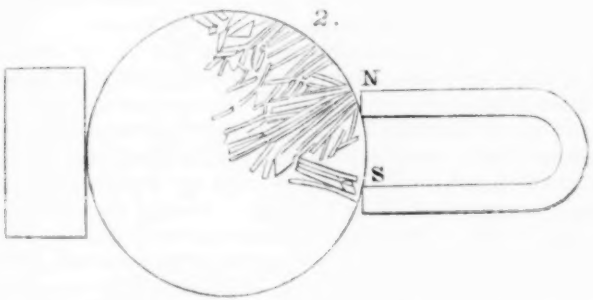


Fig. 1.

2. With a view of determining if the cooling influence of the metal had anything to do with the crystaline arrangement, portions of the same solution of nitrate of silver were put into glass capsules. One of these was placed against the poles of the magnet, and the other in contact with a mass of brass of the same weight. In the first, crystalization commenced opposite the north pole of the magnet, and proceeded slowly in regular lines to crystalize over every part; all these lines have a tendency towards the poles of the magnet. In the capsule in contact with the brass, crystalization commenced at a point furthest from the metal, and even when the fluid had become quite cold, nearly one quarter of it, which was nearest the mass of metal, remained quite free from any crystaline formation.

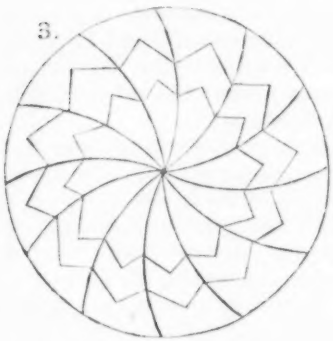
3. To exhibit this in a more striking manner, a capsule was placed between the mass of brass and the magnet, in contact with each other, as shown in fig. 2; the solution of nitrate of silver in this case, not being so concentrated as that previously used, the arrangement was allowed to remain at rest for some hours. It was then found that crystalization had taken place only over one portion of the fluid, and that immediately in connexion with the north pole of the magnet, except three long crystals which sprung from the fluid opposite the south pole, and were directed towards those springing from the north pole. This experiment was repeated four times, and, except when the solution was so concentrated as to crystalize almost immediately, the same result was obtained.



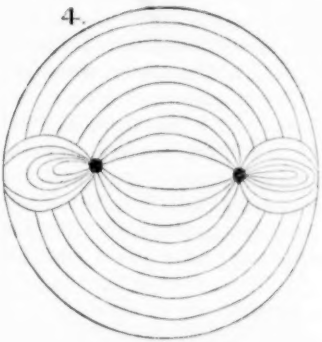
4. The phenomenon of molecular disposition under magnetic influence is pleasingly seen by a modification of the arrangement described. The two glass capsules with their solutions are placed on a plate of glass blackened on its under surface, one glass being put in contact with the brass and the other with the magnet. Their images are to be observed in the black mirror on which they rest, the light falling upon them at an angle of about 25°. As the fluids cool, the circulating currents colored by their refracting powers are seen in the mirror. In the image of the capsule in contact with the brass, no regularity of circulatory movement is observable; but in that under magnetic influence, a series of perfectly regular curved lines proceed

from the circumference to the centre; and these are crossed by small streamers springing laterally from these primary curves, presenting an appearance similar to that shown in fig. 3. These curves are constantly varying in position, but they uniformly preserve the utmost regularity.

3.

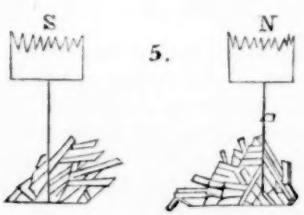


4.



5. The magnet was suspended from a tripod, and two steel needles attached to its poles; these needles were made to dip into a solution of nitrate of silver in a watch-glass. As the pellicle formed over the surface it arranged itself in a series of curved lines, as represented in fig, 4, which are strikingly similar to those produced by sprinkling iron-filing on stretched paper placed over a magnet. That these curves are due to magnetic influence there can be no doubt, as no such effect could be produced by any cooling influence, independent of magnetic excitation.

6. A similar arrangement was allowed to remain in action for twelve hours. At the end of this time crystalization had taken place in every part of the fluid, but there was an evident tendency to a curvilinear arrangement of the crystals. Around the wire depending from the north pole of the magnet, some revived silver had made its appearance: no such change was discovered at the south pole.



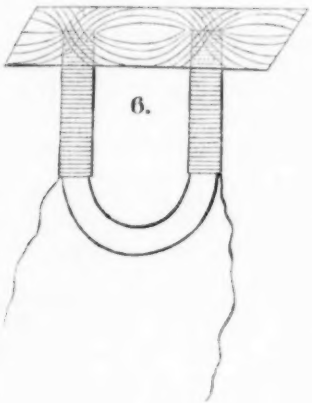
5.

7. Wires similarly suspended were dipped into a solution of sulphate of iron. Crystalization commenced around the wire at the north pole, but after a few hours crystals had formed around both of the wires, but in the greatest quantity around the north pole wire. On removing them from the solution, the crystals were found to present an arrangement similar to that represented in fig. 5, showing obviously a tendency to arrange themselves along lines of magnetic direction.

8. A solution of proto-nitrate of mercury was placed under similar circumstances; crystalization commenced at the wire suspended from

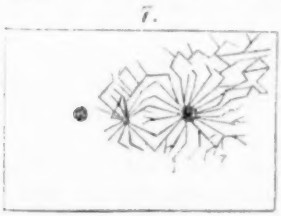
the north pole, and proceeded rapidly to a line midway between the two wires; one-half of the fluid being crystalized and the other remaining fluid. At length a few crystals formed around the wire hanging from the south pole, which all took a direction towards the opposite arrangement of crystals.

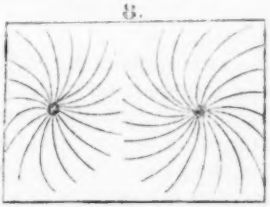
9. With a more dilute solution, the crystalization of the nitrate of mercury took place only around the wire at the north pole, and immediately at the central point between the two wires, from which small needle-shaped crystals radiated towards either pole.

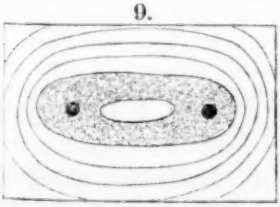

6.

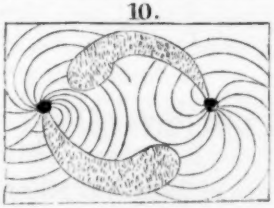
10. A plate of glass, with an edge of clay, forming a shallow trough, was placed upon the poles of an electro-magnet, capable of supporting fifty pounds when connected with a single galvanic pair excited by water acidulated with sulphuric acid. On pouring a warm and tolerably strong solution of nitrate of mercury into the trough, there was immediately formed over the surface a series of beautifully regular curves from pole to pole, as shown in fig. 6, which also represents the arrangement.

11. A similar glass trough, filled with a moderately strong solution of the nitrate of mercury, was supported on the poles of the same electro-magnet, connected with a small battery of a more permanent, but less powerful arrangement, and all was allowed to remain at rest until crystalization had taken place. The result was similar to that already described (9.), but much more strikingly shown. The order of arrangement taken by the crystals is shown in fig. 7.


7.


8.


9.


10.

12. A plate of copper with an edging of wax was placed on the electro-magnet in the same manner as the glass plate; over it a very weak solution of nitrate of silver was quickly poured; the plate immediately blackened from the decomposition of the silver salt by the copper. In about a minute the finely divided silver arranged itself into curves, as represented in fig. 8, which were after a few minutes again destroyed. By using a sheet of chemically-pure copper, obtained by electrotype deposit, I found a permanent impression of these curves could be obtained, owing to the oxidation of the copper along the spaces, which the finely divided silver, when distributed in curve-lines, did not cover.

13. A plate of hard copper, such as is used by engravers, was placed in precisely the same circumstances, and covered with a tolerably strong solution of nitrate of silver. It was left in contact with the electro-magnet for a night. On washing off the deposit of silver which covered it, it was found that the acid of the silver salt had bitten deeply into the plate over an oval space around the poles, leaving a small space between them quite bright. The copper over this etched space was covered with an immense number of minute holes; and beyond this the oxidation of the surface had proceeded in curved lines, as represented in fig. 9. We thus have permanent evidence of the influence of magnetic force in determining chemical action.

14. Into one of the glass troughs before named, placed on the electro-magnet, a weak solution of nitrate of silver was poured, and into this an equally weak solution of sulphate of iron. In about five minutes precipitation of silver commenced; this precipitate arranged itself over the glass in curves proceeding from and around the poles in the same manner as it distributed itself over the copper plate. In a short time, precipitation increasing, two curious curved spaces were formed by the fine deposit, proceeding from one pole towards the other in opposite directions, increasing in width as they proceeded, until they were abruptly checked at a little distance from the poles towards which they were directed; these spaces being very distinct from the first formed curved lines. Fig. 10 represents this very interesting arrangement.

These experiments are sufficient to show that magnetism exerts a powerful influence on molecular arrangements, and that it regulates the direction of crystaline formations. I hope to be enabled to pursue this interesting inquiry still further; it has most important bearings on many of the great phænomena of nature, and I am therefore anxious thus early in my inquiry to call attention to the singular and conclusive results which I have obtained.

6 Craig's Court, Dec. 10, 1845.

On the Solubility of Oxide of Lead in Pure Water. *By Lieut. Col.* PHILIP YORKE.

In the Philosophical Magazine for August, 1834, I published a paper on the action of water and air on lead. Some of the principal

results contained in it were confirmed by Bonsdorff in two papers; he found that 7000 parts of pure water free from access of carbonic acid dissolved one of oxide of lead; my experiments gave $\frac{1}{12,000}$th to $\frac{1}{10,000}$th. Since that time, two papers have appeared on the same subject, one by Dr. Christison,* and one by Mr. R. Phillips, Jr.† The last-named chemist considers that the oxide of lead is not dissolved, but merely mechanically suspended in the water, because the liquid is deprived of the lead by passing it through a paper filter. It is to this opinion that I propose to direct attention in the present notice.

The fact that the aqueous solution of oxide of lead would not pass through a filter was noticed by me in the paper already referred to; but as the action of tests on the liquid was just what one observes with solutions; as no time allowed for subsidence made any difference in these appearances; as the liquid deposited crystals of oxide of lead not only on the lead but on other bodies; as when decomposed by the voltaic battery it gave metallic lead at the negative pole, and peroxide at the positive; I did not consider that the stoppage of the oxide of lead by the filter was any proof of its not being dissolved. There still, however, remains this question to be answered,—In what way does the paper act in retaining the oxide? and I think that the following experiments afford an answer to the question.

I placed some clean rods of lead in bottles of distilled water loosely stopped: in this way, after removing the rods of lead, I obtained a clear liquid, which, when tested by sulphuretted hydrogen, gave a deep brown color. On passing this liquid through a double filter, which had been previously washed with hot distilled water, it appeared to be very nearly deprived of lead: when two or three fluid ounces had passed through, the filters were removed, washed, then immersed in a solution of sulphuretted hydrogen, again washed and dried. Some torn fragments of the filters were then mounted in Canada balsam for examination by the microscope. On examination with powers of from 150 to 400, the fibres of the flax composing the paper were seen to be browned, and in many instances it could be distinctly observed that the coloring substance occupied the interior of the tubular fibre. Now, it is stated by Mr. Crum, in the Philosophical Magazine for April 1844, that cotton wool possesses the power of abstracting the oxide of lead from its solution in lime-water, and that this property is made available in the processes for dying cotton with the chromates. I found that on filtering a solution of oxide of lead in lime water through a triple filter, that whereas the original solution gave a deep black when tested by sulphuretted hydrogen, the filtered liquid gave but a pale brown; and it required that the unfiltered liquid should be diluted with thirty times its volume of water to produce the same tint as the filtered.

I then tried the effect of mere immersion of the paper in the aqueous solutions before used. A bit of filtering-paper ten inches by two inches was boiled in distilled water and then put into an ounce phial filled with the aqueous solution; after remaining six hours the liquid

*Transactions of the Royal Society of Edinburgh.
†Pharmaceutical Journal for December, 1844.

was poured off and tested: it gave a pale brown, and it required that the liquid which had not been in contact with the paper should be diluted with ten times its volume of water to produce the same tint. This experiment was repeated with a stronger solution of oxide of lead in water, the water was poured off at the end of four hours, it then gave a pale brown, and it required that the original liquid should be diluted with four times its bulk of water to produce the same tint. A fresh portion of the same solution was then poured on the same paper and left for a night; then, on testing, the liquid gave a brown tint, barely perceptible, and it required that the original liquid should be diluted with from fifteen to twenty times its volume of water to produce the same.

From these experiments it is clear that the effect in question is dependent on a power possessed by the paper in common with several other porous bodies and organized fibres, of separating certain substances from their solutions, a power sufficiently well known, though little understood.* In considering this view of the subject in the present instance, there is a circumstance of some practical importance which it would appear ought to follow, viz. that after the fibres of the paper had been saturated with the oxide of lead, then this substance should pass through in solution. To ascertain whether this was the case I made the following experiments.

I obtained a strong aqueous solution of oxide of lead by immersing slips of clean lead in about three quarts of distilled water, contained in a two-necked bottle, through which oxygen gas was passed and maintained in contact with it, under a slight pressure. In this manner I procured a solution which when quite clear yielded $\frac{1}{7500}$ th of ignited oxide of lead. A filter of paper rather less than $\frac{1}{200}$ th of an inch thick and four inches in diameter was prepared and washed; then, by fitting into one of the two necks of the bottle a siphon with equal legs, so as to resemble Gay-Lussac's apparatus for washing filters (except that I used a contrivance to prevent the necessity of the air supplied to the bottle from bubbling through the solution), I was enabled to allow the filtration to go on with considerable regularity for many hours. The first portion of liquid which passed through gave a pale brown when tested; when nine fluid ounces had passed through the effect was the same as at first, and a portion (*a*) was reserved for future comparison. When forty fluid ounces had passed through, the liquid, which was quite clean, gave a much darker tint with the test than any which had previously been obtained in the experiment. It gave a tint about equal to that given with the unfiltered liquid when diluted with its own volume of water; while it (*i. e.* the last filtered portion) required to be diluted with twice its volume of water to produce the same tint as that given by the reserved filtered portion (*a*). The liquid now passed through the filter very slowly; it was tested

* The effective filter mentioned in Dr. Clark's Notice, page 384, is formed of well-washed sand, and has been in use during twelve months without any apparent diminution of power.

again, when eight more fluid ounces had passed through, with the same result as before, except that the tint was a trifle darker.

This experiment sufficiently shows that the effect contemplated does occur, and that it would be unsafe to trust to the action of a filter to separate oxide of lead from water for an unlimited time.

Proc. Chem. Soc.

New Process for Silvering Glass.

Sir,—Having made several attempts to silver glass by the process described in your Magazine, vol. xlii. p. 408, being the process described by Professor Faraday; and as many persons might be desirous of performing these experiments, which are exceedingly interesting and beautiful, and require very nice manipulation, I will describe a model which I adopted with complete success, and seldom failed in the attempt. Add to wood naptha an equal quantity of distilled water, until the naptha becomes cloudy; into this mixture put a few drops of the silver solution mentioned below, (I am supposing the vessel to be an ounce phial,) and heat the mixture in a hot-water bath. In a few days the solution will become brown; filter, and then put in a few more drops of the silver solution. Finally, put in a few drops of oil of cassia and oil of cloves; a very small quantity only is required.

In a short time the bottle containing the mixture will become of a beautiful dark purple color, and ultimately become perfectly white. A few drops more of the two oils will make more silver precipitate. The silver solution is prepared as follows:—Dissolve nitrate of silver in distilled water; pour in a small quantity of spirits of hartshorn (not the strong caustic ammonia) until a small precipitate takes place; immerse the bottle containing the mixture in warm water, and the precipitate will redissolve, and become clear.

Lond. Mec. Mag.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the Manufacture of Artificial Ultramarine in Germany. By M. C. P. Prückner, Manufacturing Chemist, at Hoff, Bavaria.

(Extract from Erdman's Journal de Chinie Pratique.)

MM. Guimet and Robiquet were the first who manufactured artificial ultramarine on a large scale for the wants of commerce; in 1830, Levercus established a manufactory in the environs of Cologne, and in 1841, MM. Leykauf, Heine & Co., also established one at Nuremberg; this is now the property of MM. Zeltner and Heine, who produce ultramarine of every different quality and price.

The process of MM. Leykauf and Heine has never been published, but the information afforded me by these gentlemen as well as the researches to which it has given rise, has induced me to give an idea of the process in the hope of throwing some light upon this branch of science.

We will first speak of the selection of the materials, which are, clay, sulphate of soda, sulphur, charcoal and a salt of iron, ordinarily green vitriol, (protosulphate of iron.)

The kind of clay employed has a great influence on the color of the ultramarine produced; it is probable that the manufacture has often been unsuccessfully tried on account of the use of a too ferruginous clay. I employ a white clay, which does not become colored in the fire and therefore contains very little iron; it is a species of dull colored kaolin, adherent to the tongue, and forming with water a meagre paste; it is found in the Principality of Reuss, in the neighbourhood of Roschitz and is employed in the fabrication of procelain; it contains about 43 per cent. of alumina. Other circumstances being the same we should prefer the clay containing the largest proportion of alumina.

The sulphate of soda employed at Nuremberg is the impure residue of the muriatic acid manufactories; it is always purified in the establishment, even when it is purchased in its refined state. This operation, to which we will again revert, is designed to separate the free muriatic acid and the salts of iron, which would alter and might even entirely destroy the blue color of the ultramarine produced.

The sulphur is the ordinary roll brimstone too well known to require description.

As to the charcoal, that from dry wood answers perfectly the desired object; sometimes coal is employed, we should then select one that is dry, rich in carbon, and giving the smallest possible quantity of white or grayish ashes without iron.

The calcination of the mixture is effected in muffles placed in a reverberatory furnace, in which it is more easy to regulate the heat and inspect the progress of the operation than in crucibles. These muffle furnaces are from 0·90 metre (35·4 in.) to 1 metre (39·33 in.) in width, and as much in depth, inside measurement. The muffles which it contains are on the inside from 0·55 metre (21·6 in.) to 0·60 in width, and from 0·30 (11·8 in.) to 0·37 high; for the sake of economy we can place two or three in the same furnace. They are constructed of refractory clay in the same manner as glass-house pots; their anterior opening is closed by a cast-iron door sliding in a groove and counterpoised; near its bottom, as well as through the muffle itself are narrow slits to admit air and observe the progress of the operation. The furnaces are provided with registers, to allow a complete control over the temperature; we may increase the durability of the muffles by supporting them on three ranges of bricks, so placed as to allow intervals between them for the free passage of the flame. When charcoal is used as the combustible, it may be added through a door in the upper part of the furnace, as in the ordinary assay furnaces.

Besides the muffle furnace, we require for the conversion of the sulphate of soda into sulphuret of sodium, a furnace resembling those employed in the manufacture of soda. In my own establishment, I have replaced the single lateral fire-place generally used by two smaller ones placed opposite to each other; experience has proved that a de-

cided economy, both of time and fuel is thus obtained, particularly with those furnaces having a hearth of more than two metres (6 ft. 7 in.) in length. The construction of the furnace is in other respects too well known to require description.

Besides these, the establishment should also contain stampers and mills, for the pulverization of the materials, &c. We will now pass on to the preparation of the materials and to the fabrication of the ultramarine.

The dry clay, broken into bits with a wooden pestle, is placed in rectangular vats, two metres long by one wide; it is sprinkled with water and then left to itself for some days; it crumbles and falls into a thick paste, which is purified by levigation and settling, as in the manufacture of porcelain, in order to separate the sand and larger particles. It is then preserved for use in vats under a close shed, in the state of a soft paste, the content of which in *dry* clay is carefully determined by trial whenever we wish to use it for the preparation of ultramarine.

To prepare the sulphate of soda, we employ, as before-mentioned, the residue of the manufacture of muriatic acid which is calcined in a reverberatory to drive off the free acid which it contains; it is broken up into fragments of one decimetre (4 in.) cube, and these plunged for an instant into water; for experience has shown that the free acid is disengaged with much more readiness from a moist than from a dry salt. These are piled up on the hearth almost to the top of the arch, arranging them in such manner that the flame may circulate freely over their surfaces. The heat is gradually raised to a nascent red, at which point all the free acid has been expelled. The calcined salt is then pulverized, either by stampers or between mill stones, into grains the size of mining powder, and mixed in a cask revolving on its axis, with the charcoal and slacked lime in the following proportions:—

Sulphate of Soda, . . .	100 parts.
Wood charcoal, pulverized, .	33 "
Air-slacked lime, . . .	10 "

This mixture is placed on the hearth of a reverberatory furnace, and covered with 3 (1·2 in.) or 4 (1·6 in.) centimetres in depth of slacked lime, which is spread over it with an iron shovel. All the doors of the furnace are then closed, and as soon as the mass is in perfect fusion it is briskly stirred, throwing in at the same time several shovelsfull of pulverized charcoal; it is then allowed to stand some time, until it no longer disengages inflammable gases from the surface of the liquid. The sulphuret of sodium is taken out with ladles and poured into flat moulds of cast-iron, where it solidifies.

The sulphuret of sodium mixed with carb. soda is dissolved out by boiling water, and the solution allowed to become clear in settling vats out of contact with the air; in these it deposits carbonate and a little sulphate of lime, and often a little crystalized sulph. soda, (which is calcined and treated as we have described) as well as some finely divided charcoal, which does not settle till after some days. It

is of extreme importance to allow it to settle for the longest practicable period, as the smallest particles of charcoal would be sufficient in the fire to alter the shade of the ultramarine. The decanted and hot solution is then saturated with pulverized sulphur, and concentrated by boiling till it contains 25 per cent. of dry bisulphuret of sodium; it has then a density of nearly 1·200, and marks 25° of the areometer of Baumé. We use 40 to 50 parts of sulphur for 100 parts of crude melted sulphuret of sodium.

After having allowed the solution of sulphuret of sodium to deposit the slight excess of sulphur which it contains, it is transferred into large matrasses of glass, which we stop with great care, to prevent the contact of air, and thus preserve it to the moment of employment.

The materials being thus prepared, we now proceed to the formation of the ultramarine: in a flat cast-iron boiler we evaporate 50 kils. (110·3 lbs. av.) of the above solution of bisulphuret of sodium to a sirupy consistency, and then add a quantity of the washed clay, still moist, equivalent to 12·5 kils. (27·5 lbs. av.) of dry clay, mixing them together as perfectly as possible with a strong iron spatula. While the mass still allows itself to be stirred easily we add, little by little, a solution of 250 grammes (3860 grs.) of crystalized protosulphate of iron, perfectly free from copper, which must be thoroughly combined. This solution of iron may be added before the clay, if it is preferred. Immediately after the addition of the sulphate of iron, the mixture becomes of a greenish yellow color, due to the formation of sulphuret of iron; the stirring is continued to perfect dryness, when, having detached the mass from the evaporator, it is to be reduced immediately to the finest possible powder.

This powder is now placed in the muffles, so as to form a layer of from 6 (2·4 in.) to 8 (3·2 in.) centim. in thickness; each muffle, therefore, contains from 15 to 20 kils. The fire is raised until the entire mass attains redness, and is continued at this heat from three-quarters up to an hour, frequently renewing the surface of the mass and allowing free access of air. The mass becomes successively colored brown, yellow, red, green and blue. This part of the operation demands much attention and skill; a low heat produces no ultramarine, whilst too high or too prolonged a heat injures very much its brilliancy.

When withdrawn from the muffle, the mass is well washed with water; the washings which contain sulphuret of sodium, and sulphate and sub-sulphate of soda, have not yet been used for any purpose; they might, however, be reused for preparing the sulphuret of sodium. The residue of the washing is drained in filter bags of close cloth, and then dried in a stove; in this state, its color is generally green, or of a blackish blue.

The dried mass being finely pulverized and passed through a silk sieve, is then submitted to another calcination, in portions of 5 to 7 kils. at a time, in muffles preserved exclusively for this purpose; these are from 0·45m. to 0·50m. (19·6 in.) wide by 0·8m. to 0·9m. (35·4 in.) in length. The fire must be moderate, as a low red heat is sufficient to produce the desired color. As soon as the blue begins to appear, we must renew continually the surface of the mass by stirring it with

an iron rod, until finally the color becomes of a pure and beautiful blue. The operation lasts from half to three-quarters of an hour, and no advantage is obtained by increasing either the time or the intensity of the heat. The powder being withdrawn is allowed to cool in contact with the air on slabs of granite: it sometimes happens that the color acquires in cooling much more fire and brilliancy.

The ultramarine is ground under granite stones of 1·5m. in diameter, and then washed and separated, according to its fineness, into different qualities, bearing the numbers $\frac{0}{0}$, 0, 1, 2, 3, 4, &c.

An excellent process to ascertain the quality of an ultramarine, consists in heating it by a spirit lamp in a glass tube through which is passed a current of hydrogen. The ultramarine will be so much the more unalterable, and its quality therefore so much superior in proportion to the time required to cause the blue color to disappear. The natural ultramarine does not lose its color until after one or two hours, and sometimes more; the artificial ultramarine of Nuremburg, marked 0, at the end of half an hour, and the poorest quality, that marked 5, after the lapse of a few minutes.

Panoramic Daguerreotype. By M. Merteus.

Acad. des Sciences, June 23rd, 1845.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

This improvement enables us to obtain with an object glass of very moderate dimensions and quality impressions of great field and exquisite sharpness. Thus with a common object glass we obtain views of 38 centim. (15.in) in length by 12 centim. (4.7 in) in breadth, perfectly distinct over the whole surface, and embracing a visual angle of more than 150°.

The means by which we obtain this result, consists, 1st., in a horizontal movement given to the object glass, by which it can be made to pass successively over all the points of the horizon. 2nd., in the curves which the plate is forced to take by means of clamps which are adjustable at pleasure: the focus of objects most unequally distant can thus be brought to the surface of the plate.

The remarkable sharpness of the impressions is caused by the use of a narrow vertical slit made in the bottom of a kind of cover which accompanies the object glass in its rotation. This slit allows only the central rays, that is, only those which have no appreciable aberration, to act on the sensitive plate.

It is essential that the position of the axis of rotation of the object glass should be determined with perfect accuracy, for unless this is the case, the images of the objects to which the apparatus is successively directed, before being extinguished and giving place to the succeeding ones, *change their position* on the ground glass and of course also on the plate; all distinctness is then impossible.

We obtain this proper position of the axis with respect to the object glass, by moving the latter more or less in the tube which carries it, until the condition of perfect immobility of the images is at length obtained.

Bul. Soc. Encourage.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Prize for Effecting Chemical Decomposition by the Dry Way.

From the Proc. of the Societe d' Encouragement. Sitting of June 11th, 1845.

On behalf of the Committees of Chemical and Mechanical Arts, M. Dumas read the following programme of a prize of the value of 6000 francs, to the person making the first practical application of the action of the voltaic pile, to effect chemical decomposition by the dry way.

"It has long been known that the pile of Volta effects chemical decomposition when metallic solutions or moist bodies are interposed between its poles; it is also known by the numerous experiments of Davy, and those of Mr. Faraday, that the pile can effect the decomposition of dry bodies, provided that they are reduced to a state of fusion by heat.

"But, although decomposition by the wet way has become the base of the electrotype, of galvanic gilding, &c., yet the processes founded on the decomposition of bodies by the dry way has as yet received no practical application. Nevertheless it appears to result from experiments made in England, by M. Napier, that electricity can be applied in this form to effect profitable decompositions; that it can extract copper from the sulphuret of copper; that it can disengage from melted iron several hurtful elements, and can effect these reactions with economy compared with the effects which it produces in the wet way. "The society desires to encourage experiments tending to confirm the use of electricity in analogous cases; it wishes to secure the immediate study of some useful process, but it leaves to the competitors perfect liberty as to the particular application which may serve to effect this object. The society will therefore award the prize to an application of this kind, made on a practical scale and fully described. "In case the prize should not be completely merited, the Society reserves to itself the right to reward the attempts which may have been made, by gratuities deducted from the amount of the prize. The competition will close on the 31st December, 1846.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Obituary of the late GEORGE CRANE, ESQ., *the founder of the Anthracite Iron manufacture. By* SOLOMON W. ROBERTS, *Civil Engineer.*

George Crane, Esq., the founder of the Anthracite Iron manufacture, died at his residence near Swansea, South Wales, on the 10th of January, 1846, in the 62nd year of his age. Mr. Crane was a native of Broomsgrove, Worcestershire, and for fifteen years was engaged in the hardware business in Birmingham, from which he retired about the year 1820, with no intention of again engaging in business; but, becoming tired of an idle life, he visited Wales in 1823, and commenced making iron at the Yniscedwin works, which then consisted of one small blast furnace. Those works are situated in

Breconshire, in the picturesque valley of the Tawy, a small river which flows into the Bristol channel at Swansea, and they are thirteen miles from that port. When Mr. Crane took charge of them, and for a long time after, the smelting of the iron ore found in the vicinity was carried on with coke made from bituminous coal; but, as an extensive field of anthracite coal existed in the neighbourhood, which was considered useless for smelting purposes, his attention was early turned to the importance of bringing that fuel into use; and at different periods, during fourteen years, he had, at a large outlay, tried a variety of plans to effect the object.

Though repeatedly baffled he still persevered, and his efforts at length were crowned with complete success. Finding that the use of this hard and refractory fuel caused his furnace to chill, he resolved to try the effect of heating the blast to a temperature sufficient to melt lead, upon the plan so successfully introduced by Mr. Nielson, for increasing the yield of furnaces worked with bituminous coal.—Having made the necessary preparations, he began the experiment with the hot-blast on the 7th of February, 1837, in a furnace forty-one feet high and eleven feet in diameter at the boshes. From that date until the 12th of March the furnace was worked with roasted anthracite as the only fuel, and thenceforward exclusively with raw anthracite as it came from the mine without any preliminary preparation. In all respects Mr. Crane's success was complete; his furnace worked well, the yield was better than with coke, and the iron was of superior quality. He felt that the problem to which so many experimenters had turned their attention, both in Europe and America, and to which he had devoted so much of his time, was triumphantly solved. He had accomplished the object on an extensive working scale, with continued and increasing success; and from this period dates the establishment of a new and important manufacture, from which the iron trade, both of Great Britain and the United States, is now deriving great advantages. The writer of this notice, who was at that time sojourning among the iron works in Wales, visited Mr. Crane's establishment in May, 1837, for the purpose of seeing the process and of satisfying himself that the materials used were similar to those which exist so abundantly in Pennsylvania. Finding that the great object was accomplished, and that the results were highly gratifying, he communicated the fact to his friends in Philadelphia, by whom it was shortly after made public through the newspapers. At that time there was no blast furnace in Pennsylvania working with anthracite coal; their number in the State is now twenty-seven, and there are several in New Jersey.

At the meeting of the British Association for the Advancement of Science, held in Liverpool, in September, 1837, Mr. Crane attended and presented a paper descriptive of his process, which is printed in the sixth volume of the proceedings of that association. He had secured a patent in Great Britain and had applied for one in the United States, the issue of which was for some time delayed, owing to obstacles which grew out of the premature publication of his process. When great difficulties have been overcome by simple means men

are prone to depreciate the inventor, and in proportion to the number of the individuals and to the importance of the interests benefitted, is the pertinacity with which his claims are contested. After he has made plain a path before untrodden, his merits are questioned as those of Columbus were by the Spanish courtier, whom the great Genoese so keenly rebuked by placing an egg on its end. Mr. Crane's case formed no exception to this general rule. His patent was infringed, and he became involved in a tedious and expensive litigation which some of his friends feared might end in his ruin. At length, however, the question as to the validity of his British patent was decided in his favour, and thenceforward it became a source of much profit to him. He extended his works at Yniscedwin by the erection of several additional furnaces, and his concerns became highly prosperous. The validity of his patent in the United States has not been tested, although his process is extensively used. He consulted the writer of this notice as to the expediency of entering into litigation on the subject in this country; who in reply compared the case of Mr. Crane to that of Eli Whitney, the inventor of the cotton gin, the value of whose invention to the public made it the source of such vexation to the patentee. Mr. Crane is undoubtedly entitled to the honor of being the first to establish the smelting of iron with anthracite coal. At the time he succeeded, the business did not exist, and ever since it has gone on increasing. In testimony of this, the important works of the Lehigh Crane Iron Company have been named after him, which were erected and are carried on under the able superintendence of Mr. David Thomas, who was sent out from Wales by Mr. Crane for that purpose.

Having lived long enough to see the object on which his heart was set completely accomplished, Mr. Crane died suddenly from the effects of a painful accident. Being somewhat indisposed, he had received two small bottles containing medical prescriptions, one intended to be used internally and the other as a liniment; and, by mistake, on the night of the 8th of January last, he accidentally took the contents of the wrong bottle, which produced inflammation of the stomach and carried him off in two days, notwithstanding the best medical aid.—He was a man of great excellence and purity of character, warmly attached to the Episcopal church, but liberal to those of different opinions. He was a friend to the poor and active in visiting and relieving the sick. He always provided for the widows and orphans of his workmen, and saw that their orphan children were educated.—His active exertions to promote the general welfare and the moral and religious improvement of those in his service, furnish a bright example for the imitation of other iron-masters. He died unmarried, but hundreds who were employed by him lament his loss as that of a father. He felt a lively interest in the preservation of peaceful relations between Great Britain and the United States, and took great pleasure in hearing of American prosperity. We have reason to trust that his spirit has passed from works unto rewards in a better and more enduring country.

Philadelphia, March 4th, 1846.